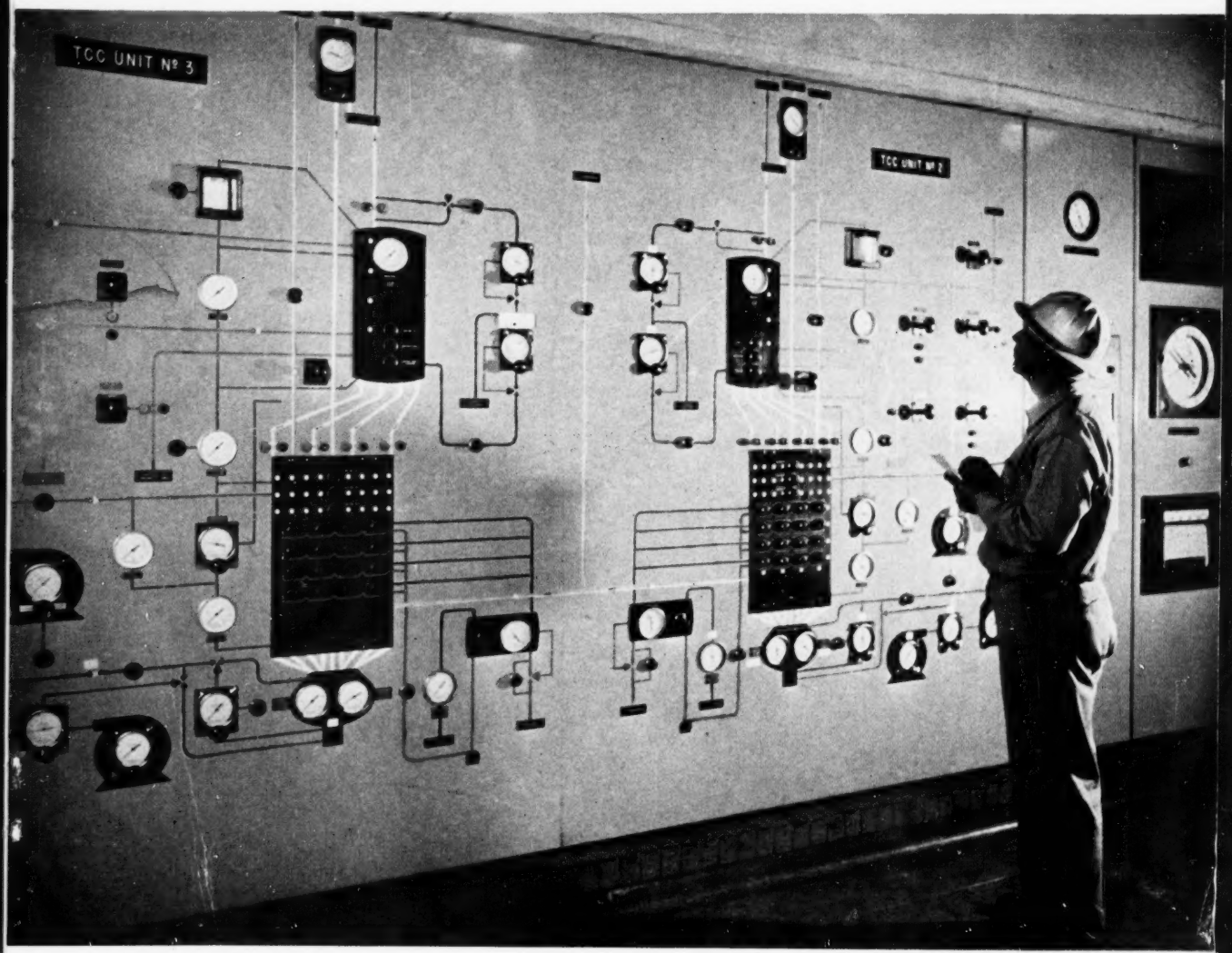
Instruments

THE MAGAZINE OF
MEASUREMENT · ANALYSIS · COMPUTING
INSPECTION · TESTING · CONTROL



Graphic Panelboard installed by Lummus Company in Magnolia Petroleum Company's Thermofor Catalytic cracking units 2 & 3. *(Photo courtesy Falstrom Company, Passaic, New Jersey.)*

Including the
JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA (Page 881)
and the
JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION (Page 873)

Vol. 26 No. 6
JUNE • 1953

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A NEW FACTUAL METHOD OF SIZING CONTROL VALVES FOR FLASHING CONDENSATE SERVICE

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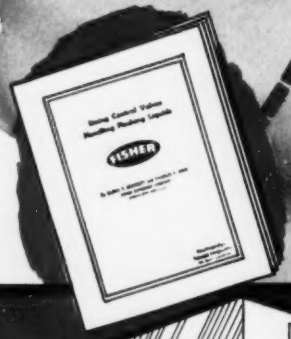

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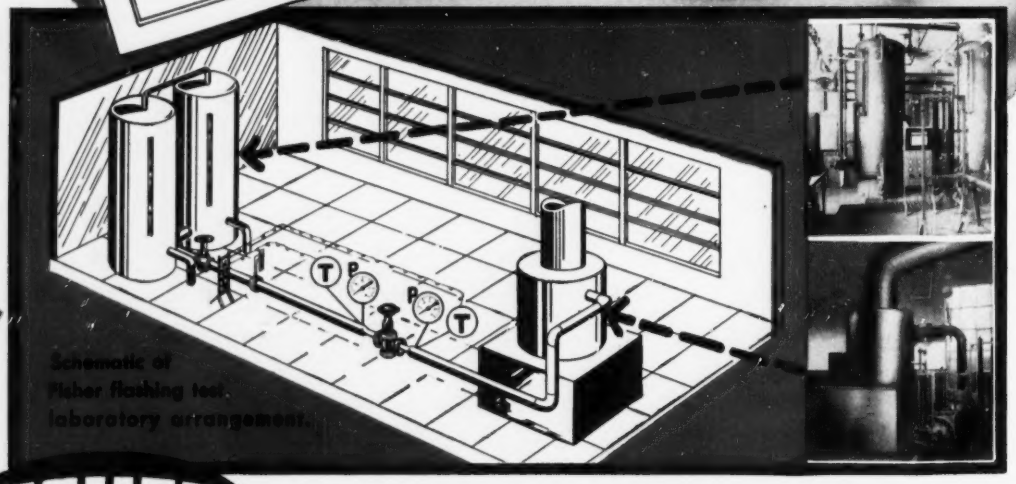

Schematic of Fisher flashing test laboratory arrangement.

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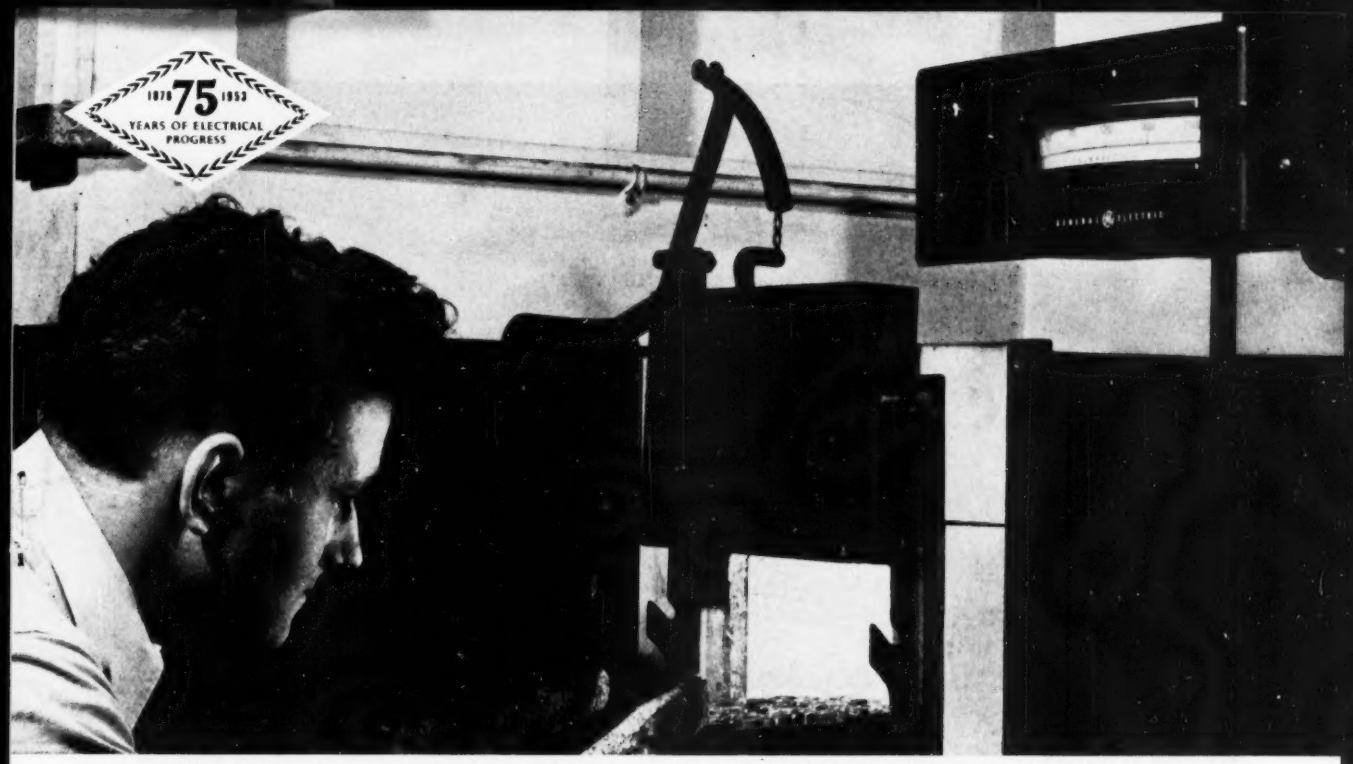

OPERATOR REMOVES TRAY OF STEEL PARTS FROM ANNEALING FURNACE. G-E PYROMETER FURNISHES THE REQUIRED PRECISION CONTROL.

on small furnaces, ovens, kilns . . .

Use G-E Pyrometers for Precision Process Control

For single-unit process control jobs, such as the annealing operation shown above, cost takes on extra importance. General Electric's line of pyrometers offers relatively inexpensive control for common applications where reading accuracy within ¾ of 1% is permissible.

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PRECISION CONTROL is your assurance that G-E pyrometers will read the same every time temperature conditions are the same. That's repeatability—the essence of precision control. A repeatable process means identical results, so important to modern industrial production.

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Accuracy is held to within ¾ of 1% of full scale.

SEVERAL TYPES AVAILABLE, including indicators, indicator controllers, and protectors. Offered in either 2-position or 3-position models for flush or surface mounting. Scale requirements can be fulfilled from a variety of temperature ranges in the 0-3000F span.

FOR COMPLETE INFORMATION, contact your G-E Apparatus Sales representative, or write for Bulletin GEC-713 to General Electric, Section 602–255, Schenectady 5, N. Y.

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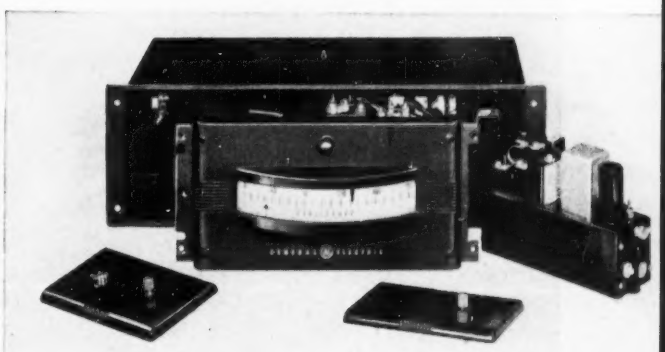
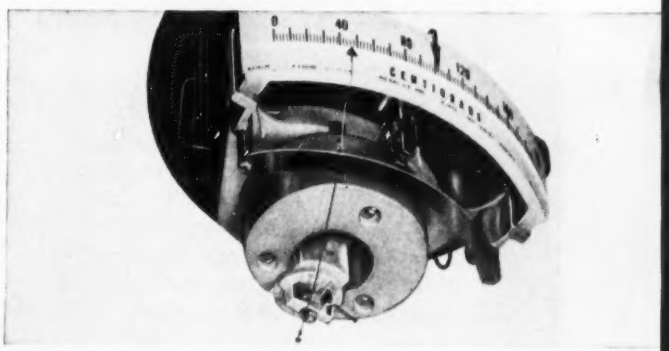
GENERAL ELECTRIC



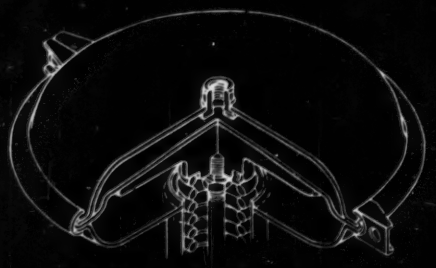
EASY MAINTENANCE is evident in such G-E construction features as the plug-in indicator and control units—replaceable in a moment.



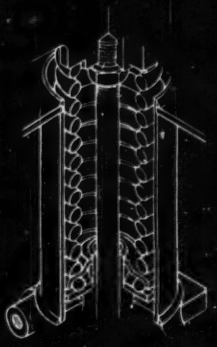
SHOCK-RESISTANT CONSTRUCTION sustains accuracy with light moving-unit, 3¼-lb. alnico magnet, and sturdy stationary parts.

For more information circle 2 on inquiry card.

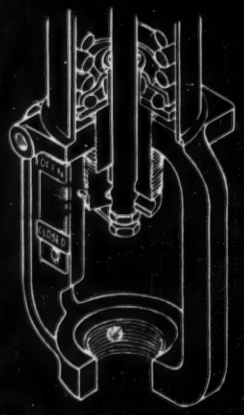
THERE'S NOTHING LIKE A



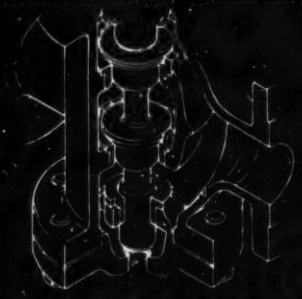
The K & M molded diaphragm has an exceptionally large effective area and it maintains full contact with the diaphragm button throughout the full valve stroke.



The heavy, long-travel K & M valve spring is calibrated for precise deflection rate. It combines with the large diaphragm to provide an exceptionally high power-factor. Inner valve positioning is extremely precise.

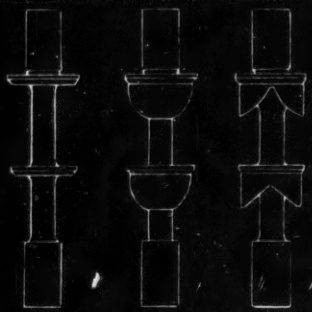


Steel spring barrel and steel yoke provide the strength required for long, hard, shock-resistant service.



Body flow passages are a minimum of 140% of comparable pipe size area—smooth, turbulent-free, high capacity flow is assured. Inner valve open areas average 80% of comparable pipe area—pressure drop takes place principally through the inner valve where it is fully controllable.

The K & M method of Teflon packing utilizes molded rings of shredded Teflon, retained by solid Teflon top and bottom rings. The need for compression members is eliminated, and with it the danger of corrosion or contamination of packing box parts.



K & M inner valves are available in wide variety to provide desired flow characteristics for all process applications.

For more information circle **3** on inquiry card.

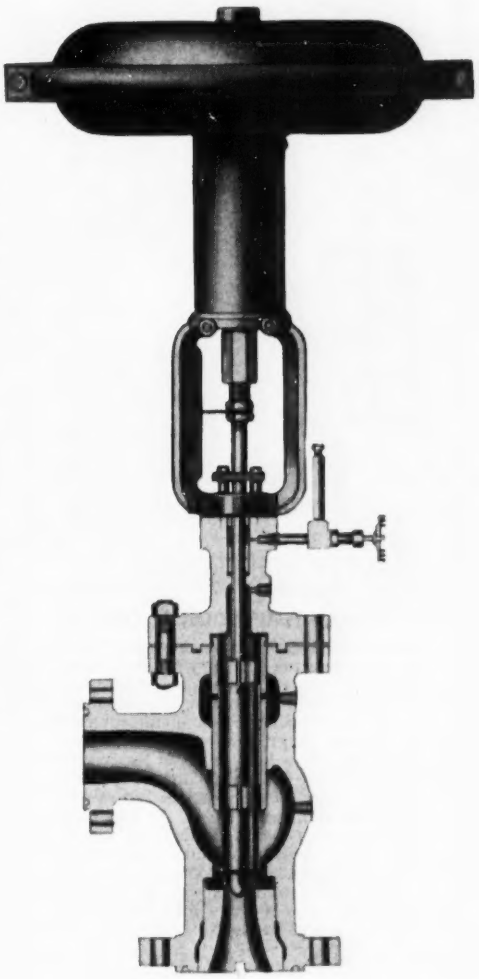
K&M CONTROL VALVE

No other control valve has the features of a K & M valve. No other control valve is designed so explicitly to meet the requirements of modern instrumentation.

No other control valve is backed by an organization so wholeheartedly interested in helping instrument engineers to solve exacting application problems.

NEWEST K&M CONTROL VALVE

The K & M Type 1460 is a new angle valve especially developed to handle high pressure drops and fluids containing slurry, sludge, coking and similar contaminations. It is particularly adapted for applications in modern refineries and petro-chemical plants. Available in sizes to handle pressures up to 1,500 pounds, and can be furnished in various metals and alloys for highly corrosive and high temperature service.



K&M **KIELEY & MUELLER, INC.**

Valve Makers Since 1879

MIDDLETOWN, NEW YORK

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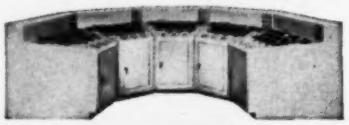
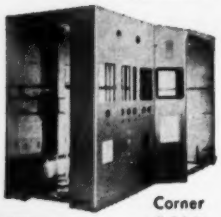
Quality is assured with
FALSTROM

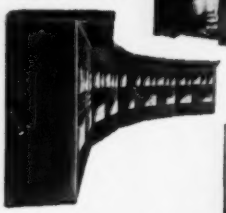
INSTRUMENT PANELS
and CONTROL BOARDS



Benchboard Console



Five Section Cubicle Control Board and Lighting Canopy



Corner Cubicle Section

Refinery Cubicle with Mimic Flow Diagram in Color

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Experienced designing and quality fabrication assure the efficiency of any indicating, recording, or control installation. Whether you are planning new construction, modernizing existing installations or adding to present equipment, FALSTROM offers long years of experience and the most modern facilities for fabricating to your specifications or recommending standard designs. In any case, by specifying FALSTROM you specify the highest possible quality metal working techniques known to the industry. Estimates on your needs will be supplied promptly—call or write FALSTROM to arrange a consultation.

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DESIGNERS, ENGINEERS AND BUILDERS OF CUSTOM METAL PRODUCTS FOR INDUSTRY

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Instruments
THE MAGAZINE OF MEASUREMENT INSPECTION · TESTING · CONTROL

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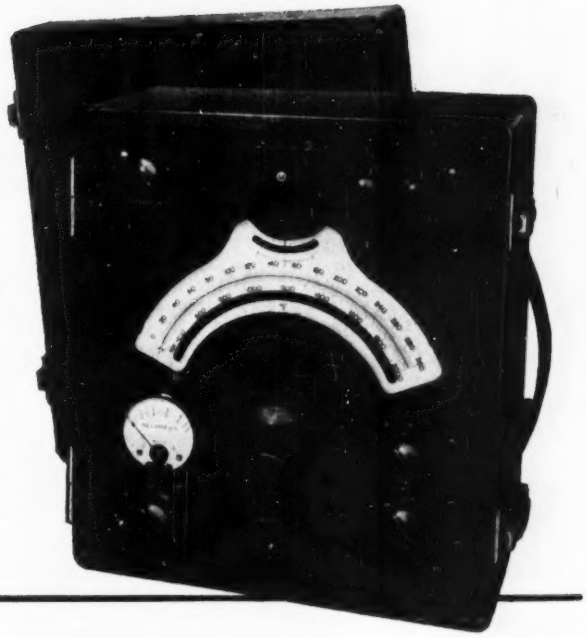
LEWIS PORTABLE PYROMETER POTENTIOMETERS

FOR MEASURING TEMPERATURES ELECTRICALLY

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY



ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

- Three models from which to choose the instrument for your application.
  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

THE LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

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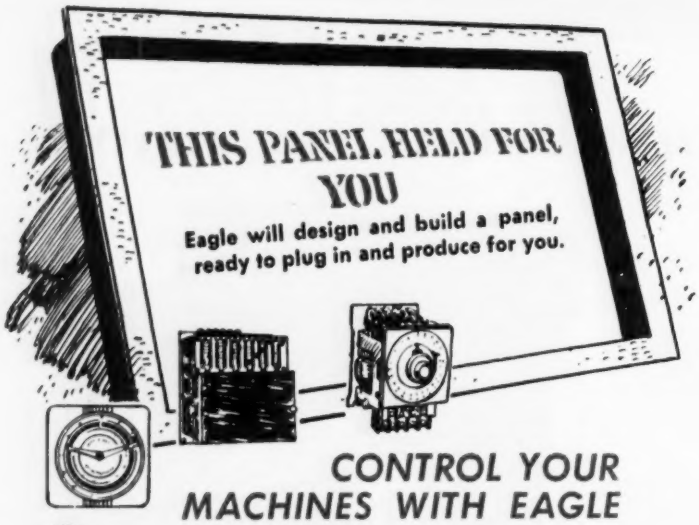
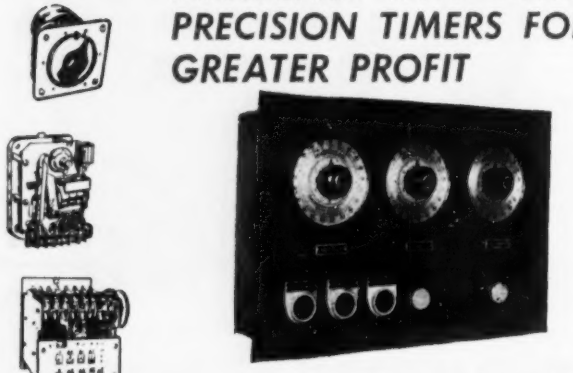
LET EAGLE TIMERS MAKE YOUR PROCESS AUTOMATIC



CONTROL YOUR MACHINES WITH EAGLE PRECISION TIMERS FOR GREATER PROFIT



Eagle "know how" engineers, (without obligation), will study your individual process and suggest the right timer to improve the quality and speed-up production of your product. You can save countless man-hours for greater profit with Eagle precision timing or counting.

A WIDE VARIETY OF TIMERS AND COUNTERS FOR YOUR SELECTION

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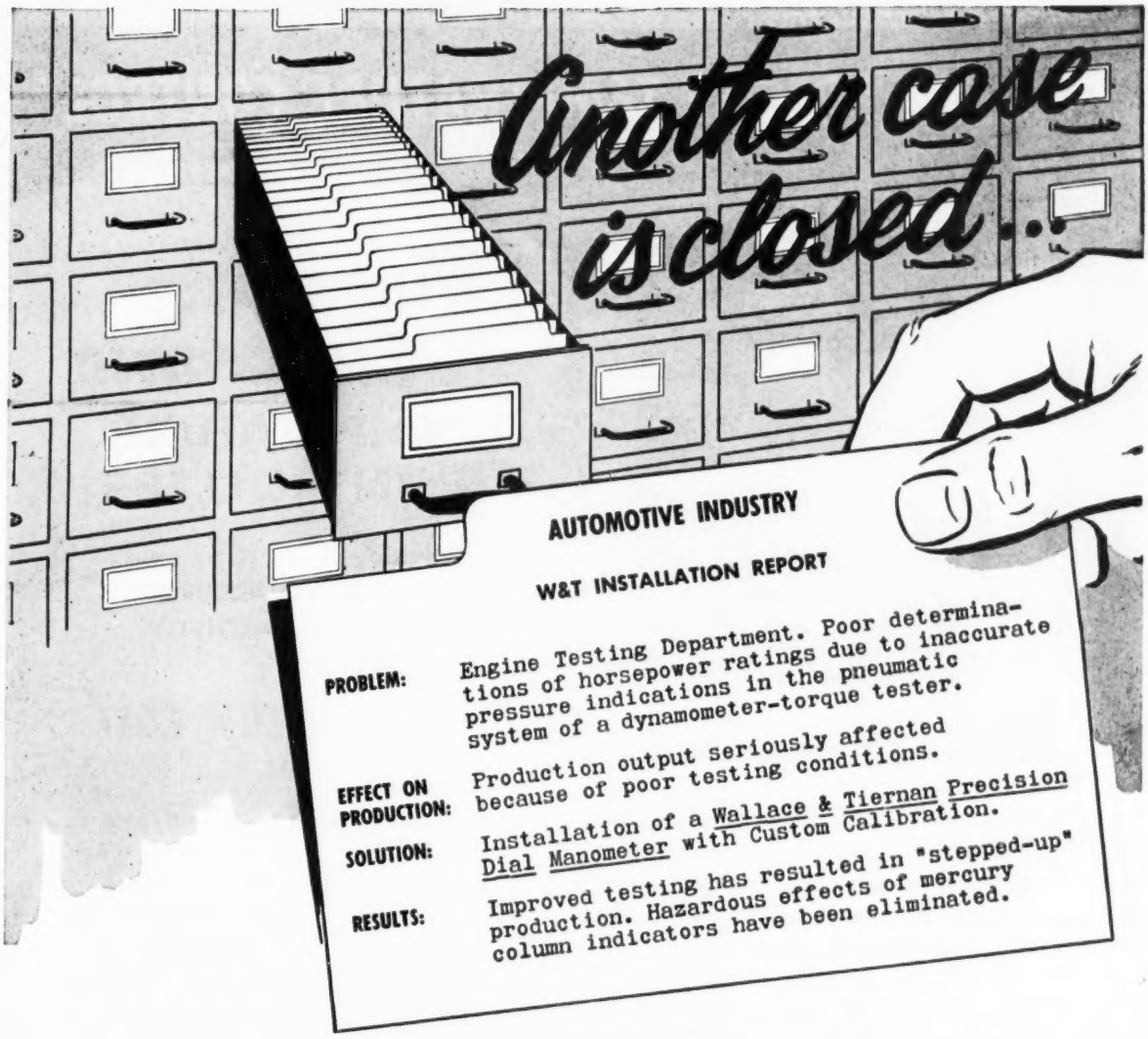
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AUTOMOTIVE INDUSTRY
W&T INSTALLATION REPORT
PROBLEM: Engine Testing Department. Poor determinations of horsepower ratings due to inaccurate pressure indications in the pneumatic system of a dynamometer-torque tester.
EFFECT ON PRODUCTION: Production output seriously affected because of poor testing conditions.
SOLUTION: Installation of a Wallace & Tiernan Precision Dial Manometer with Custom Calibration.
RESULTS: Improved testing has resulted in "stepped-up" production. Hazardous effects of mercury column indicators have been eliminated.

...Thanks to a W&T Precision Instrument

W&T Precision Dial Manometer

FEATURES:

Full protection against overpressure
Custom calibrated scales in units of force or torque
Two revolution indicator provides scale 45 in. long with only an 8½ in. diameter dial.
Sensitivity one part in 10,000; accuracy one part in 1000.
If you have a problem in the measurement or control of pressure, write today for additional information.

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For more information circle 7 on inquiry card.

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Thermo Electronic TEMPERATURE CONTROLLERS

provide
NULL BALANCE ACCURACY
ELECTRONIC SENSITIVITY
AND SPEED

AT LOW COST

Now, with Thermo Electronic Controllers, thermocouple and resistance bulb types, you can afford accurate, automatic temperature control on processes and equipment operating between −100°F and 3000°F. The two-position control action is continuous and high speed, only one part—a magnetic control relay—moves positively when the process calls for a change of heat. Both types of controllers incorporate a null balance circuit for high measuring accuracy with an electronic control system for sensitivity and speed. Calibration is guaranteed to within plus or minus ¼ of 1% of full scale range. Bright signal lights indicate temperature conditions and are clearly visible over wide angles and great distances.

Outstanding features of Thermo Electronic Controllers are simplicity of design and sturdy and compact construction. They are easy to install, economical to operate, and require little maintenance. Severe vibration or mechanical shock will not affect the measuring accuracy or control sensitivity.

TELL US ABOUT YOUR TEMPERATURE CONTROL PROBLEM OR WRITE FOR

Thermocouple Pyrometer Controller Bulletin 50F
Resistance Bulb Controller Bulletin 55F

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Protection Tubes
Quick Coupling Connectors
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Resistance Bulbs
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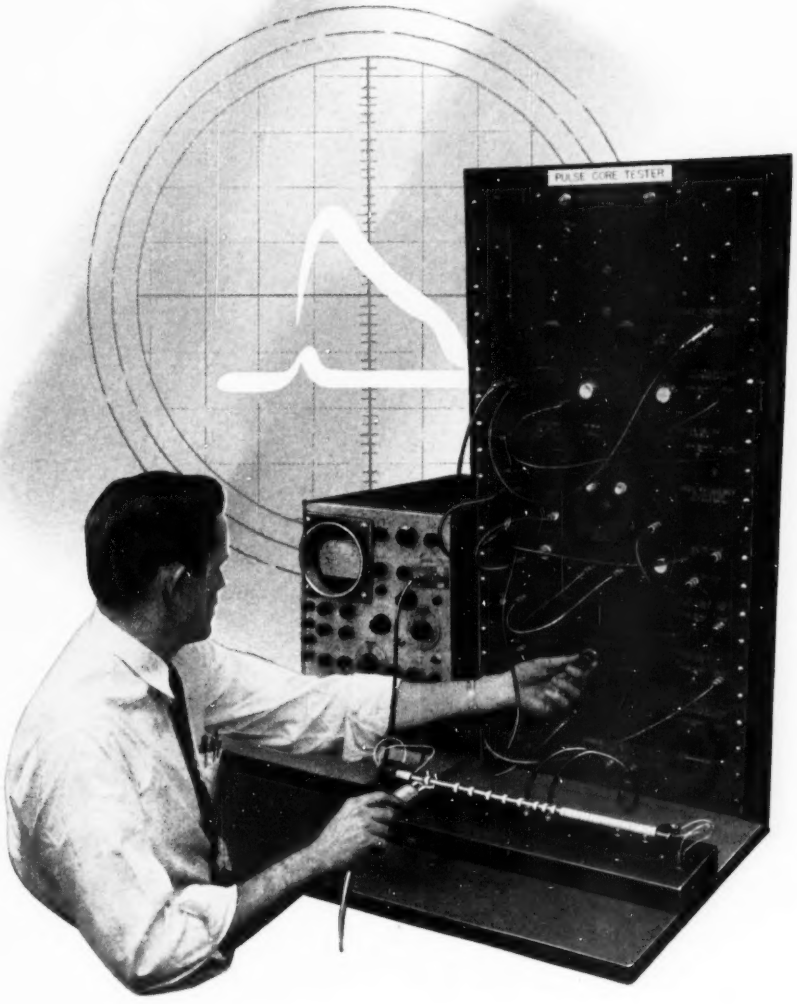
For more information circle 8 on inquiry card. Circle 9 on inquiry card. →

"UNITIZED" PULSE CONTROL EQUIPMENT



Saves valuable research and testing time

Always in the past, it has been necessary to custom design pulse test equipment for each individual application—this has proved a most costly and time-consuming engineering operation. But now the major portion of this work can be eliminated through the use of Burroughs "Unitized" Pulse Control Equipment. These standardized units are complete within themselves and each performs one basic operation, such as generating, mixing, gating, counting, etc. The units can be arranged and rearranged in almost any manner necessary to simulate actual conditions of usage for the component part being tested.

FOR APPLICATIONS IN RADAR, TELEMETERING DIGITAL COMPUTING, TELEVISION AND NUCLEAR PHYSICS

AS AN EXAMPLE—MEASURING THE BEHAVIOR OF MAGNETIC CORES

Pictured here is a Burroughs Core Tester BCT-300 designed to swiftly and accurately measure the "switching time" and "squareness ratio" of toroidal cores. The unit is made up of eight standard Pulse Control units (one Low Frequency Pulse Generator 1004C, a Flip-Flop 1101C, a Coincidence Detector 1201B, and five Pulse Delay units 1301C) mounted in a rack with other accessory equipment. The output of this unit may be observed on a standard laboratory oscilloscope. Power is supplied from a 9101C power supply.

This BCT-300 is typical of the many possible applications of Burroughs "Unitized" Pulse Control Equipment. Pertinent characteristics and specifications of the individual units will be found on the following pages.

ELECTRONIC INSTRUMENTS DIVISION

Burroughs

Plan a block diagram of the circuit you need - - -

note how

PULSE GENERATOR

Type 1004C — Generates 0.1 microsecond pulses at frequencies continuously variable from 15 to 650,000 cycles per second, in five overlapping bands. Output circuit is designed to match 93-ohm RG-62/U cable.

A symmetrical multivibrator is used to control the frequency. The output amplitude, which is not affected by changes in frequency, can be varied from 10 to 32 volts and the polarity of the output pulse is reversible.

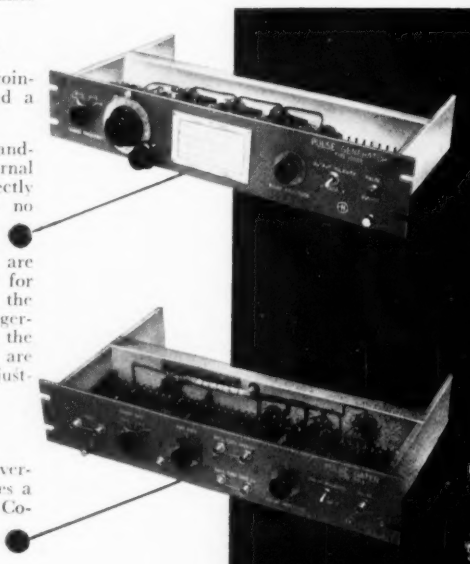
Type 1002B — Generates 0.1 microsecond pulses (approx.) at frequencies continuously variable from 0.2 megacycles to 4.5 megacycles in four overlapping bands.

A calibrated, L-C controlled, sine-wave oscillator controls the frequency. The output amplitude, which is only affected by frequency changes in the ranges above 2 megacycles, can be varied from 10 to 32 volts and the polarity of the output pulse is reversible.

Type 1003A — This unit consists of three separate pulse generators mounted on a single panel, each section of which is capable of generating 0.1 microsecond pulses in three different ways.

1. Single pulse push-button operation.
2. The output pulse is generated by coincidence action of a push-button and a positive synchronizing pulse.
3. The output circuit acts as a pulse standardizing circuit when fed by external pulses. The output circuit is directly triggered by an input pulse with no push-button action.

Two inputs for each pulse generator are provided: one, "Synchronizing Input," for synchronization of push-button pulses; the other, "Low-frequency Input," for triggering the output circuit directly, without the use of the push-button. Positive pulses are available with output amplitudes adjustable from 0 to 35 volts.



PULSE GATER

Type 1501B — This unit comprises a gate generator with a manually adjustable gate length and an independent coincidence detector. The duration of a gating pulse is continuously adjustable from 0.3 microseconds to 5,000 microseconds in four overlapping ranges. The Pulse Gater replaces a Pulse Delay Unit, a Flip-Flop, and a Coincidence Detector for the purpose of generating pulse trains.

COINCIDENCE DETECTOR

Type 1201B — Two independent coincidence detectors are mounted on one panel. These units are designed to sense coincidence between the output signal of a flip-flop and 0.1 microsecond pulses. Two inputs are provided for each unit. Grid No. 1 is designed to accept 0.1 microsecond pulses with minimum amplitudes of 13 volts. Grid No. 3 is designed to accept the output of Type 1101C flip-flop or equivalent.

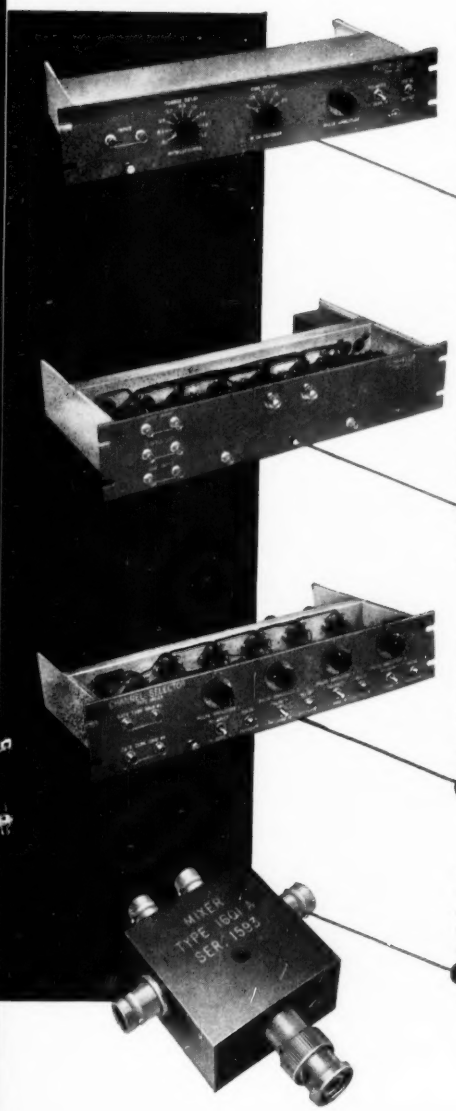
Type 1202A — Two separate coincidence detectors are mounted on one panel. Each is designed to sense coincidence between the output voltage levels of as many as five flip-flops.

The principal difference between this unit and the Type 1201B coircidence detector is that the Type 1201B is designed to sense coincidence between a flip-flop output and 0.1 microsecond pulses, while the Type 1202A is designed to sense coincidence between output of one flip-flop and as many as four other flip-flops.

As many as six inputs may be driven in parallel from a single flip-flop output.

"UNITIZED" PULSE CONTROL EQUIPMENT

shown here can be mounted on a 19-inch rack and arranged to fit your specific requirements



PULSE DELAY

Type 1301C – In this unit, a 0.1 microsecond input pulse triggers a single-shot multivibrator of controllable period, and a 0.1 microsecond pulse of reversible polarity is regenerated at the end of the multivibrator period. The delay of the 0.1 microsecond output pulse is continuously adjustable in five overlapping ranges from 1 microsecond to a maximum of about 80,000 microseconds.

In addition, a rectangular pulse with a duration equal to the delay period between the 0.1 microsecond input and output pulses is brought out to a jack on the front of the panel through a d-c coupled cathode follower so that it can be used for observing the time delay oscilloscopically.

Type 1302A – This unit delays 0.1 microsecond pulses by means of a tapped delay line in 0.05 microsecond steps from 0.1 to 1.9 microseconds. Reversible output polarity of variable amplitude is also provided.

Type 1303B – This unit, which provides a fixed delay of 0.1 microsecond is designed to be connected in cascade with RG-62/U coaxial cable without mismatch. Input and output cable connectors are mounted on a flanged box 4½ x 3 x 1¾ inches.

FLIP-FLOP

Type 1101C – The flip-flop is a bistable circuit designed specifically to provide an output voltage level to be used as a gate in coincidence circuits. The unit contains a pentode Eccles-Jordan circuit capable of being switched at rates up to 2.5 megacycles per second with 0.1 microsecond pulses.

There are three inputs – zero, one, and complement–operating with minimum amplitudes of 12 volts. Two output jacks marked "Zero Gate" and "One Gate" supply either 0 volts or −23 volts at an impedence level of approximately 680 ohms.

There are two neon lights on the front of the panel which indicate the position of the flip-flop. There is also a terminal block on the rear of the unit which can be used to operate indicator lights installed at a remote point for visual monitoring.

GATED CHANNEL SELECTOR

Type 1402C – This unit is designed to sense coincidence between the output signal of a flip-flop and 0.1 microsecond pulses and to feed the output to four separate jacks. The input section is similar in action to that of coincidence detector, Type 1201B. Each of the output pulse positions has its own amplitude control and three-position toggle switch which is used to select pulse polarity or reject the output pulse. The ability of the unit to select any or all of the four output circuits in any combination permits the unit to be set up for a parallel binary code, where each output can be used to represent a single binary digit. The unit is also useful for feeding as many as four terminated lines from a single source.

MIXERS

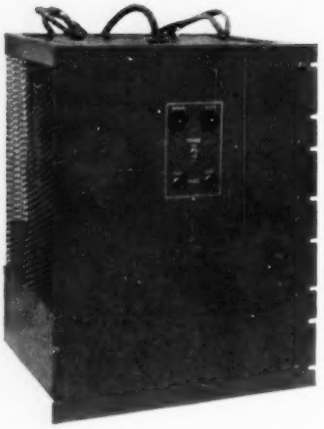
Type 1601A—This mixer has four input positions which feed a common output through crystal diodes. Four standard input connectors and one output connector are mounted on a box 2½ x 2½ x 1 inch.

Type 1602A—This mixer is a panel-mounted twin mixer functionally equivalent to two of Type 1601A except with five input connectors and one output connector for each mixer.

ELECTRONIC INSTRUMENTS DIVISION

Burroughs

Burroughs Accessory
PULSE CONTROL EQUIPMENT
-necessary for fast circuit assembly



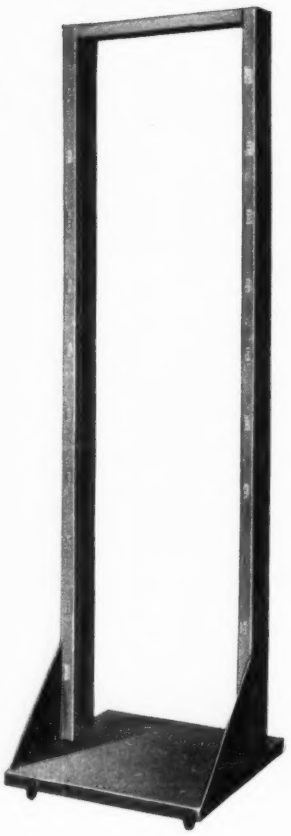
◀ POWER SUPPLY—Type 9101C

This unit is a magnetically regulated d-c power supply providing the seven voltages necessary for the operation of several pulse generators, flip-flops, coincidence detectors, etc. Each d-c voltage is automatically regulated to within ±1 per cent of the selected voltage for load variations from 10 per cent load to full load, and for a-c line input variations of ±8 per cent. Two separate transformers, each with tapped primaries and two secondaries, supply a total of 50 amperes of heater current at 6.3 volts.

The unit, which is operated from a 115-volt, 60-cycle, 20-ampere single-phase power source, has each of the seven output voltages interlocked by relays, thus providing protection from loss of voltage in any of the supplies, and has fuses for over-current protection.

MOUNTING RACK—Type 7002A ▶

This is a standard 19-inch relay rack with plug-in power outlets available along each side. Approximately 70 inches of mounting space are available. Overall dimensions of the swivel-caster unit are 73¼ x 20 x 21. It is finished to match the remaining units in the line.



A few current users of "Unitized" Pulse Control Equipment

Massachusetts Institute of Technology
University of Michigan
Consolidated Engineering Corporation
National Union Radio Corporation
The Catholic University of America
Stanford Research Institute
Magnetics Research Company

Originally created to speed up and simplify the building of electronic test equipment at the Burroughs Research Center, "Unitized" Pulse Control Equipment is now being used by many leading organizations in electronic research.

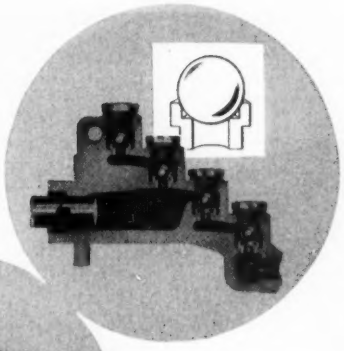
More than 500 of these pulse control panels were used in the construction of the high speed digital computer now in operation at the Burroughs Research Center. They represent the primary reason why it was possible to complete this unique machine in only nine months.

Incidentally, the services of the Burroughs computer are now available, on a fee basis, to interested organizations, both public and private. Typical computer users and their solved problems are: Westinghouse Aviation Gas Turbine Div. —*Turbojet engine design and performance calculations.* Philco — *Antenna calculations.* Bell and Howell — *Optical ray tracing.* Hydrocarbon Research, Inc.—*Stresses in pipe.* Roger Bellows & Associates— *Correlation of psychological tests on personnel.*

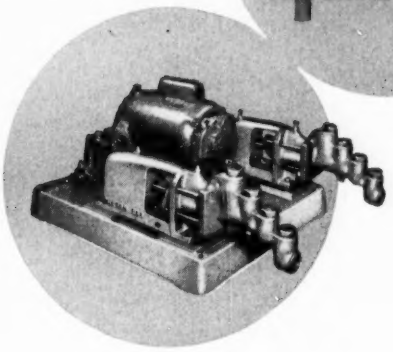
• • •

For full information and consultation regarding Burroughs "Unitized" Pulse Control Equipment, the Burroughs Digital Computer, or other problems related to electronics or magnetics, call or write Department 15, Electronic Instruments Division, Burroughs Research Center, 511 North Broad St., Philadelphia 23, Pa.

ELECTRONIC INSTRUMENTS DIVISION
Burroughs



Basic design simplicity of the *exclusive* Milton Roy liquid end step-valve assures high and reproducible volumetric efficiency. The self-cleaning *double* ball-checks seat positively, dislodge any trapped particles by spinning action, are snap-acting.



Chemical Treatment Costs Drop with this Milton Roy Pump

CONTROLLED VOLUME PUMPING

INSTRUMENTATION

PROCESS CONTROL SYSTEMS

BLENDING AND FORMULATING

ON THE JOB in a well-known chemical processing plant, this Milton Roy Motor-Driven Controlled Volume Pump meters the flow of concentrated sulphuric acid to the deoiling step in an ore flotation process. The accurate control of acid addition results in minimum usage of concentrated sulphuric acid and subsequent caustic, thereby lowering treatment costs.

This is a typical example of how Milton Roy Pumps effect dollar savings in hundreds of applications throughout industry. As motor-driven or air-powered units, or as components of automatic systems, their accuracy and long service life bring measurable returns to users. In *boiler feed water treatment*, for example, they are used in all forms of handling internal or external treating chemicals; in *petroleum processing*, for crude desalting and gasoline treating; in *textile manufacturing*, for acid, alkali or bleach baths; in *instrumentation*, to satisfy control requirements.

These are rugged, dependable pumps. They meter practically any liquid—abrasive slurries, solids in suspension, solvents—in capacities from 3 milliliters per *hour* to 45 gallons per *minute*, against pressures up to 25,000 pounds per square inch with instrument accuracy. We invite your inquiries.

Bulletin No. 553 tells you how you can profitably use Milton Roy Motor-Driven Controlled Volume Pumps in your business. Write for your free copy.

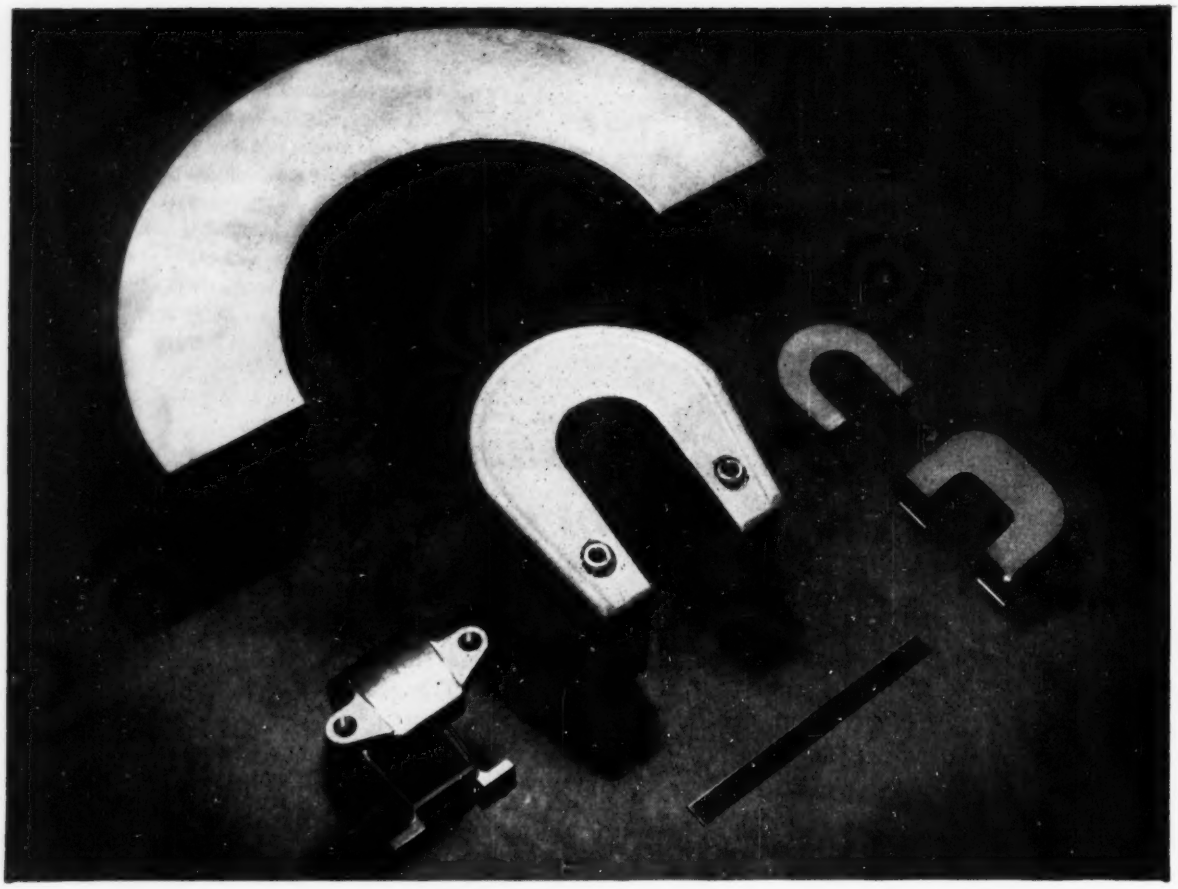
MILTON Roy COMPANY

Manufacturing Engineers • 1309 E. MERMAID LANE • PHILA. 18, PA.

Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

← Circle 9 on inquiry card. For more information circle 10 on inquiry card.



PERMANENT MAGNETS and ASSEMBLIES for Magnetrons and Traveling Wave Tubes

The group of magnets illustrated above, weighing from a fraction of a pound up to 75 pounds, are indicative of the wide range of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need, with die-cast or sand-cast aluminum jackets, Celastic covers, etc. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified . . . magnetized and stabilized as desired. ● *Let Arnold handle your magnetron and traveling wave tube permanent magnet requirements.*

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Made to your Specifications

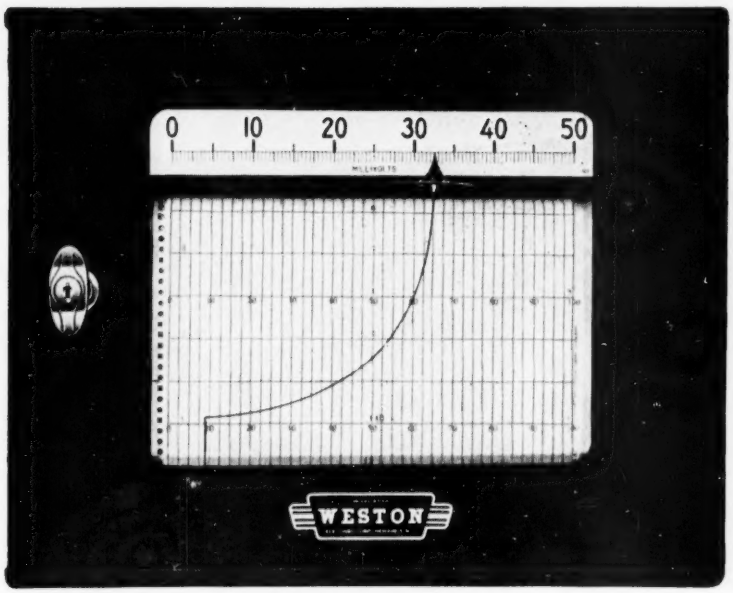
. . . ANY SIZE, SHAPE OR COATING REQUIRED

★ *We'll welcome your inquiries*

For more information circle 11 on inquiry card.

Circle 12 on inquiry card. ⟶

THE Simplicity Features INSTRUMENT MEN PREFER



Simplified WESTON Recording Potentiometer

Here is the recorder that has been widely acclaimed by instrument men because its new design concept has contributed new simplicity and new economies in instrument operation and maintenance. More compact, too; and its rugged construction gives it new resistance to vibration and shock, assuring sustained high accuracy over longer periods. Can be used to measure and record temperature, d-c current, d-c voltage, resistance, a-c voltage, a-c current, speed, speed ratio, power, frequency, hydrogen ion (pH), light intensity or any other quantity that can be converted into electrical values. The whole story is available in booklet form. Write for your copy today. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

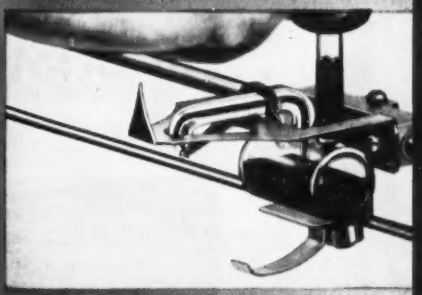
Representatives in all principal cities. In Canada . . . Powerlite Devices, Ltd., Montreal, Toronto.

WESTON

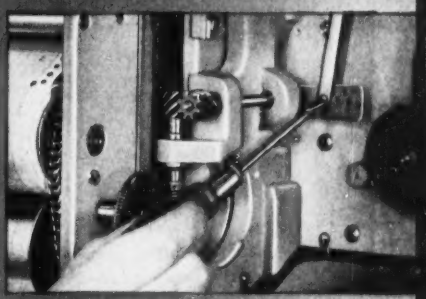
WESTON *Instruments*

INDICATE — RECORD — CONTROL

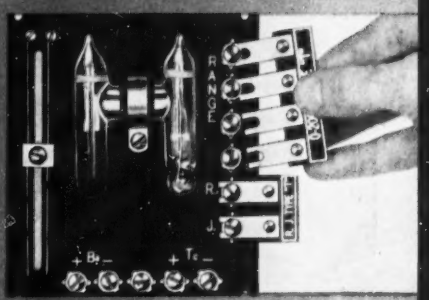
TO CHANGE CHARTS, you simply swing chart frame open a full 180°, insert chart and swing it over timing drum and across front of frame and fasten. No loose pieces to handle!



TO REFILL PEN, simply open chart frame completely exposing pen for quick, easy filling. Recorder continues operation and charts remain in time sequence during filling.

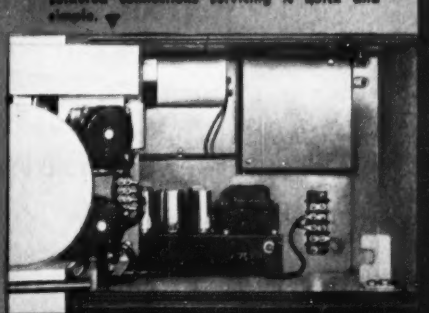


TO CHANGE CHART SPEEDS, a simple screwdriver adjustment gives you a choice of 5 different speeds. These speeds are doubled or quadrupled by changing one worm and gear assembly.



TO CHANGE RANGES, you simply substitute the desired range standard. The reference junction compensation is changed in like manner. No soldered connections to break!

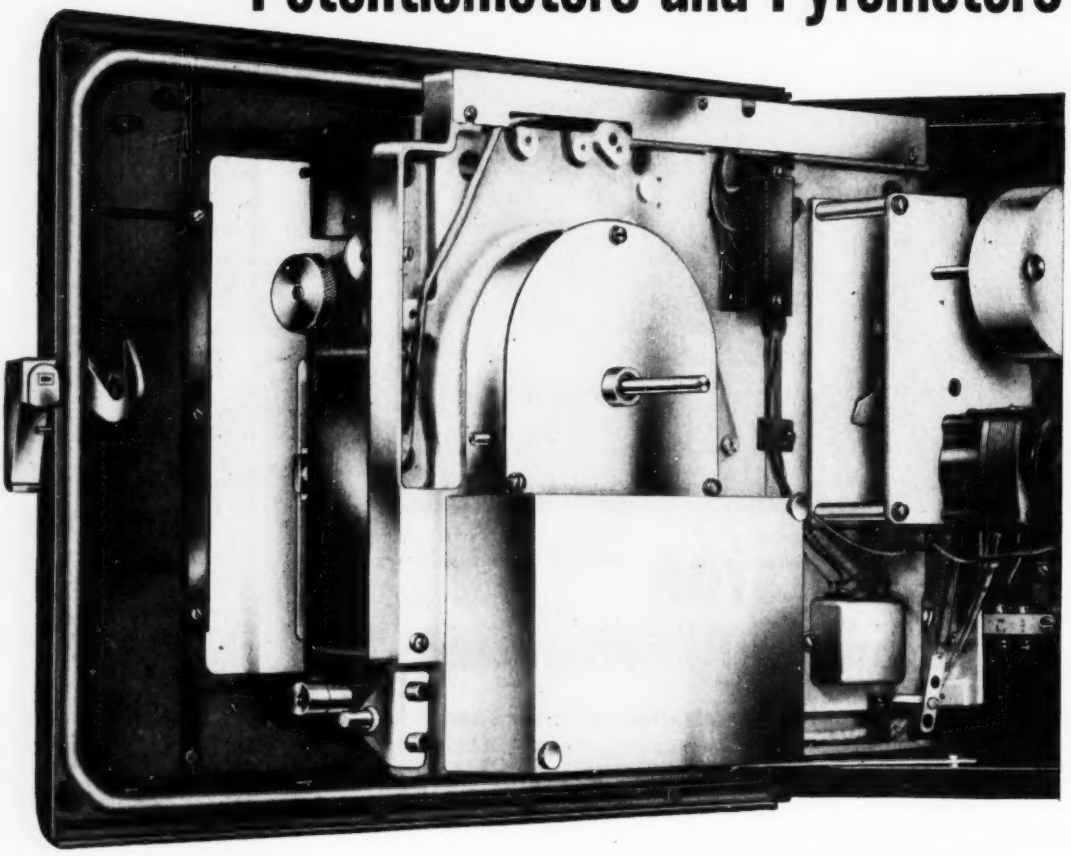
TO REMOVE THE AMPLIFIER, you simply take out two screws and pull two plugs. With no soldered connections servicing is quick and simple.



WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL . . . .

CONTINUOUS STANDARDIZATION

...in Bristol Electronic Dynamaster Potentiometers and Pyrometers



LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle 13 on inquiry card.

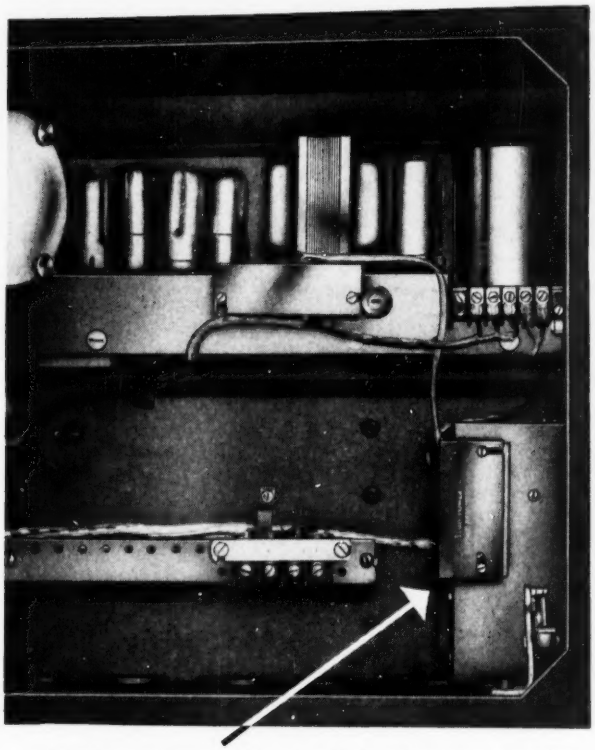
WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL

with no dry cells

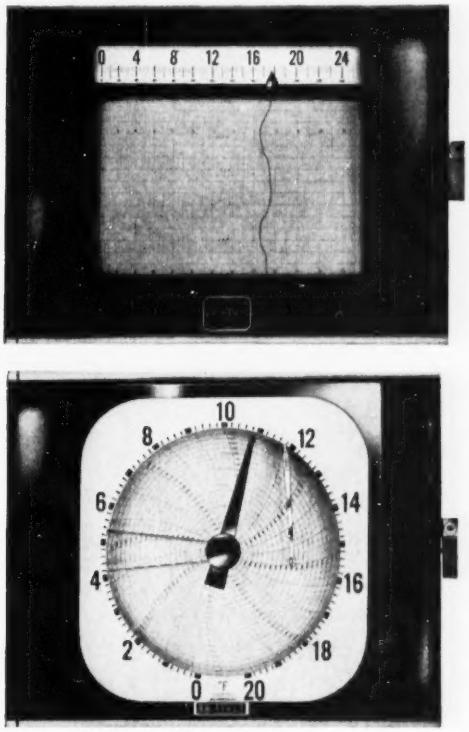
• **CONTINUOUS STANDARDIZATION** eliminates need for dry cells—supplies voltage that is continuously compared with standard cell.

• **CONTINUOUS OPERATION—NO TIME OUT.** With continuous standardization, the potentiometer is free to continuously measure, record, and control. No time out or interruption is required for periodic standardization.

• **NO STANDARDIZING MECHANISM:** Continuous standardization is taken care of electrically. The absence of a standardizing mechanism simplifies the instrument considerably.



Continuous Standardization Unit: Eliminates dry cell—no interruptions in the operation of the potentiometer for standardization—no standardizing mechanism.



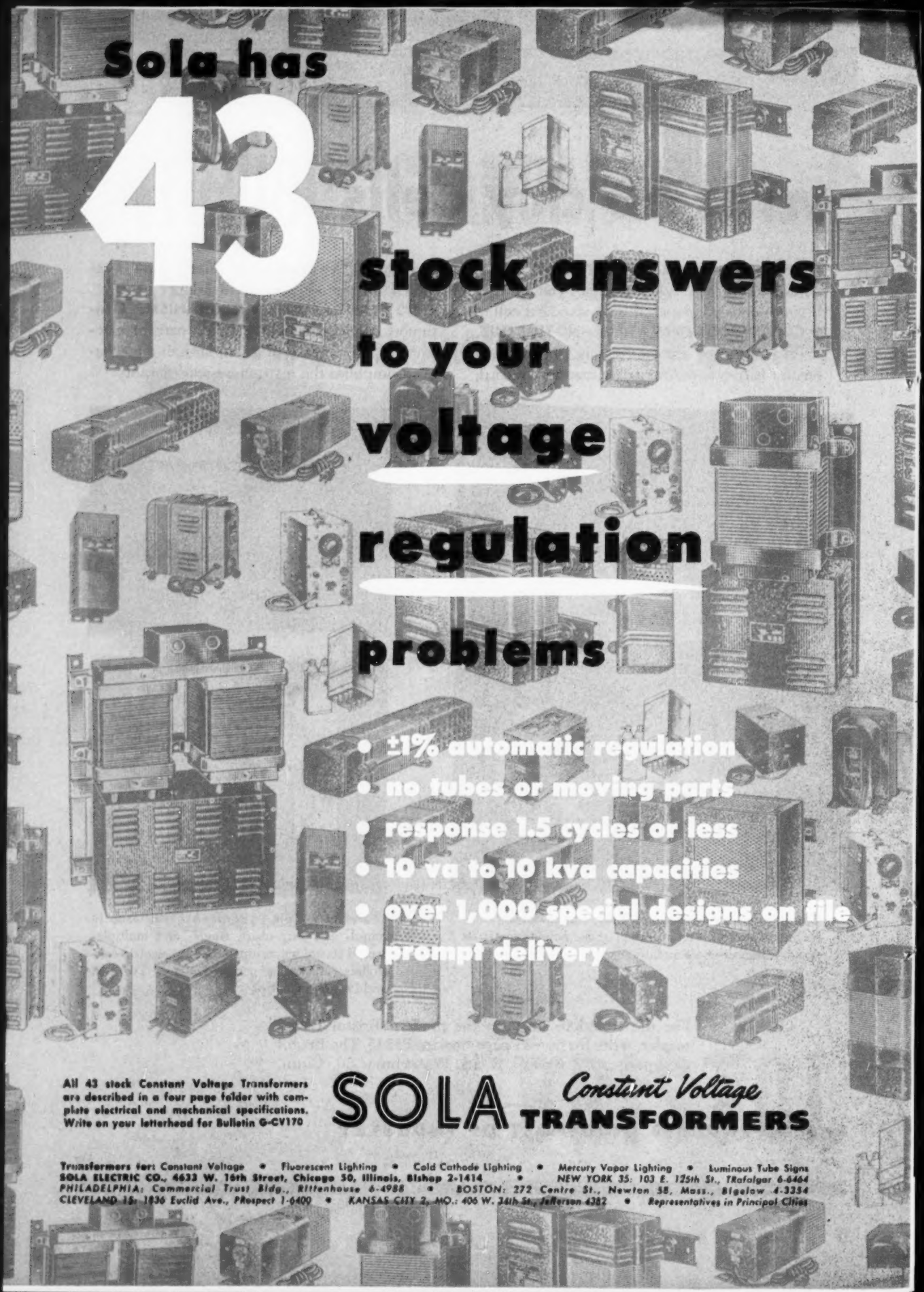
Bristol Electronic Dynamasters are made in round- and strip-chart, single- and multiple-record recorders, air-operated and electric controllers (all types of control actions). Two-pen and Program Control.

For the complete story on the modern Bristol Dynamaster, write for free 35-page booklet P1245. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

THE DEPENDABLE GUIDEPOST OF INDUSTRY

3.17

For more information circle 13 on inquiry card.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stock answers
to your
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problems
• ±1% automatic regulation
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• response 1.5 cycles or less
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CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., JeFferson 4382 • Representatives in Principal Cities

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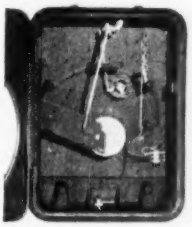
The most convertible, most interchangeable, most maintenance-saving instrument you've ever seen.

Deliberately designed so that the basic elements are identical for the 6", 9" and 12" chart size recorders. Temperature and pressure systems are also completely interchangeable. This flexibility enables you to convert instruments to suit your changing needs, at a minimum cost, minimum inventory, and without delay at the job site. Control through air relay or solenoid easily added. Full details in Catalogs 400 and 500.

What you can do with the Gotham Convertible

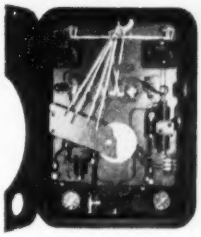
Function	Chart Size 6"	9"	12"
1-Pen Recorder	X	X	X
Single Temperature or Pressure Controller, Indicating	X	X	X
2-Pen Recorder*		X	X
3-Pen Recorder*			X
4-Pen Recorder*			X
1-Pen Recorder-Controller		X	X
2-Pen Recorder-Controller*			X
1-Pen Recorder-Controller and 1-Pen Recorder *			X
1-Pen Recorder-Controller and 2-Pen Recorder *			X

Functions above may be either Temperature or Pressure or Mixed (*)

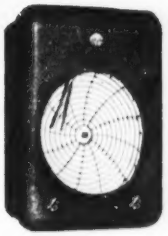


IT'S A TEMPERATURE RECORDER

IT'S A PRESSURE RECORDER



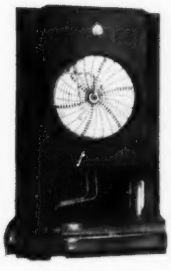
IT'S A TEMPERATURE OR PRESSURE RECORDER AND CONTROLLER



EXTERIOR OF THE GOTHAM CONVERTIBLE

AUTOMATIC TIMING CONTROLLER

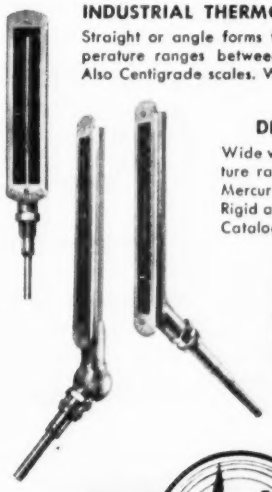
Multiple cam type, designed to start and control a sequence of process operations. Opens or closes air valves or electric switches. Available in single cam type. Write for Catalog 500.



RECORDING PSYCHROMETER

Wet and dry bulb. Motor driven suction-type blower. Standard chart drive. Similar design available for Recording and Recording-Controlling Hygrometers. Write for Catalog 400.

PORTABLE RECORDERS—Handy, light-weight, mercury or vapor actuation, 6", 9", 12" chart sizes. See Catalog 400.



INDUSTRIAL THERMOMETERS

Straight or angle forms for all purposes. Temperature ranges between —40°F. and 950°F. Also Centigrade scales. Write for Catalog 100.

DIAL THERMOMETERS

Wide variety of case styles, temperature ranges, connections and fittings. Mercury, vapor, or gas-actuated. Rigid and adjustable stems. Write for Catalog 200.

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Controls either temperature or pressure vs. time. Controls and records time, rate of rise, hold value, and rate of cooling. All adjustments in this new instrument made from outside of case. Write for Catalog 500.

Keep Everything Under Control With Gotham

GOTHAM INSTRUMENTS

Division of AMERICAN MACHINE AND METALS, INC.
Sellersville, Pennsylvania

For more information circle 15 on inquiry card.

← Circle 14 on inquiry card.

Announcing the **STANDARD** ELECTRONIC TACHOMETER

for P·R·E·C·I·S·E·L·Y measuring speed and frequency

- Takes Less Space (12" x 12" x 8")
- Uses Less Power (100 Watts)
- Has Fewer Tubes (Twenty-two)

EASIER TO READ . . . MORE RELIABLE . . . UNIT PLUG-IN CONSTRUCTION

SINCE 1884

STANDARD

Write for Bulletin #200

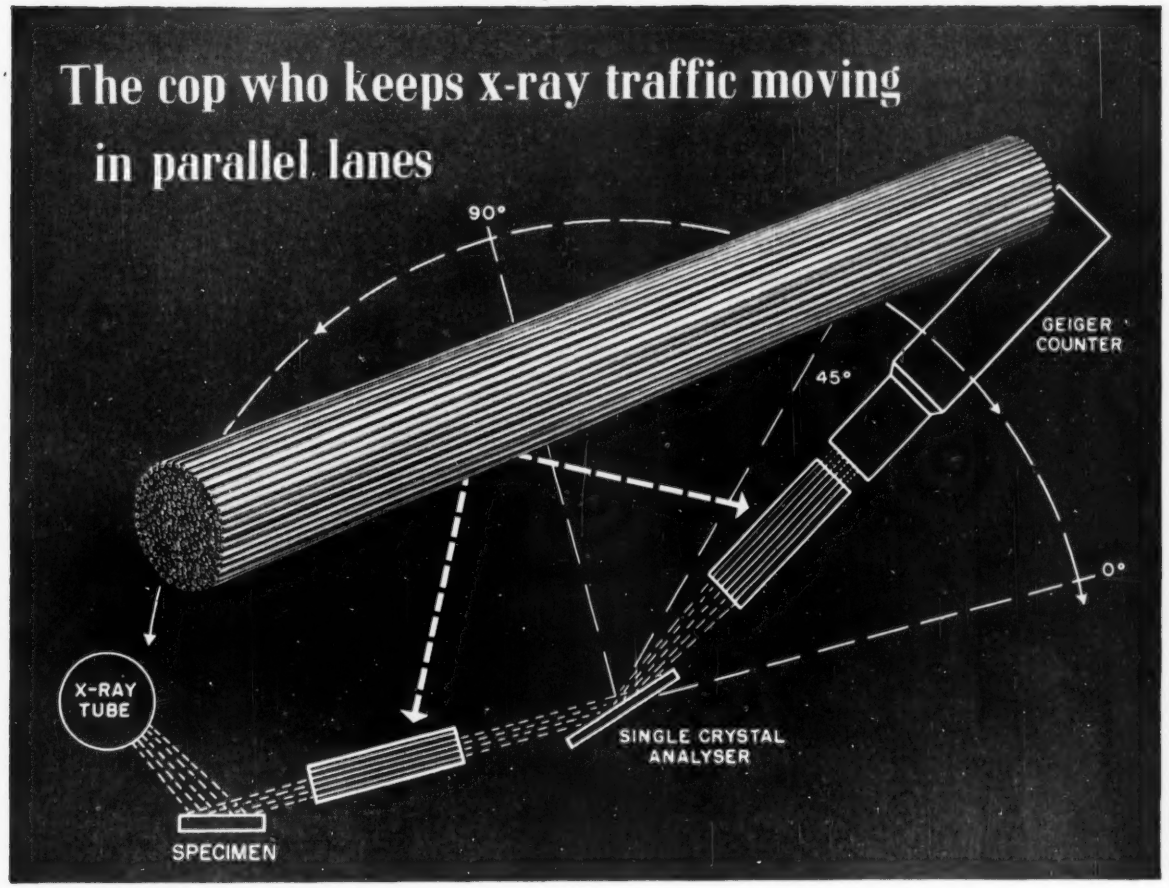
The STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

For more information circle 16 on inquiry card.

The cop who keeps x-ray traffic moving in parallel lanes



Fluorescence analysis is the new, fast way to find out which elements and how much of each are in alloys—without destroying the sample of the alloy.

This trick is accomplished by bombarding the alloy specimen with X-rays using a Fluorescence Analysis Unit produced by North American Philips, Inc. The x-radiations of each element bounce off the specimen only to be separated according to wavelength and measured.

As the x-radiations leave the specimen they shoot through bundles of fine tubes known as "collimators". The collimator acts as a kind of traffic cop, keeps the rays moving in parallel lanes, reduces divergence. This is an interesting job, and we're pleased that North American Philips chose Superior fine nickel tubing for it on the basis of its uniformity in diameter, wall thickness and finish.

Undoubtedly you have opportunities where tubing could be helpful—as a carrier, a weight-saving structural member, or as a shape that saves machining time. Look into the variety of forms, sizes, and analyses Superior produces to tight specifications. Take advantage of the experience and testing facilities that Superior brings to focus on your problem. Tell us the nature of your application and we'll send you information and a Data Memo by return mail. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Round and Shaped Tubing available in Carbon, Alloy, and Stainless Steels, Nickel Alloys, Beryllium Copper, Titanium and Zirconium.

Superior

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West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331

All analyses .010" to ⅝" O.D.
Certain analyses (.035" Max. wall) up to 1⅜" O.D.

For more information circle 17 on inquiry card.

TO MEET YOUR *Service* NEEDS PROMPTLY

SUPERIOR ELECTRIC VOLTAGE CONTROL EQUIPMENT IS AVAILABLE THROUGH AN ELECTRICAL DISTRIBUTOR CONVENIENTLY LOCATED NEAR YOU

There is an Electrical Distributor in your territory who carries comprehensive stocks of SUPERIOR ELECTRIC Voltage Control Equipment. He is a specialist carefully selected for his knowledge of your requirements and his ability to give you prompt, courteous service. He is as near as your telephone. Call him for your voltage control requirements.

TO MEET YOUR *Voltage Control* NEEDS BETTER

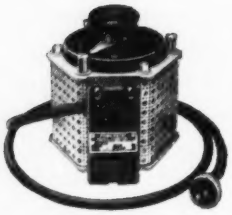
SUPERIOR ELECTRIC VOLTAGE CONTROL EQUIPMENT IS AVAILABLE IN A COMPLETE LINE FOR THE MAJORITY OF APPLICATIONS

SUPERIOR ELECTRIC designs, engineers and manufactures Voltage Control Equipment specifically to meet today's demands. A wide range of standard types in numerous capacities and ratings are offered. In addition, The Superior Electric Company — thoroughly experienced in the field of voltage control — offers to work with you in developing special equipment to meet your special needs exactly.

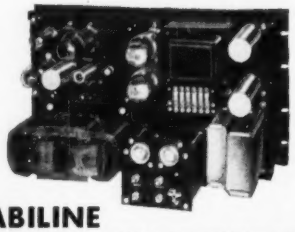
REGULARLY *Stocked and Sold*

BY OVER 1,600 LEADING DISTRIBUTORS THROUGHOUT THE COUNTRY

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

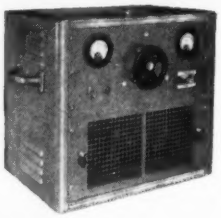


POWERSTAT
VARIABLE TRANSFORMERS

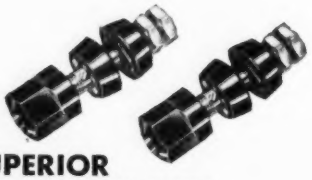


STABILINE
AUTOMATIC VOLTAGE REGULATORS

VOLTBOX
A-C POWER SUPPLIES



VARICELL
D-C POWER SUPPLIES



SUPERIOR
5-WAY BINDING POSTS

THE SUPERIOR ELECTRIC CO., 706 Mae Ave., Bristol, Conn.
Please send me the name of the Electrical Distributor nearest me who stocks SUPERIOR ELECTRIC Voltage Control Equipment.

I am interested in ☐ POWERSTAT Variable Transformers ☐ STABILINE Automatic Voltage Regulators ☐ VARICELL D-C Power Supplies ☐ VOLTBOX A-C Power Supplies ☐ 5-WAY Binding Posts.

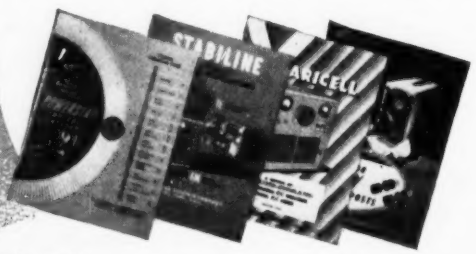
NAME

POSITION

COMPANY

CO. ADDRESS

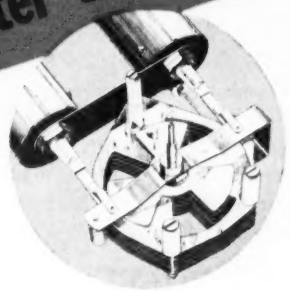
CITY ZONE STATE



For more information circle 18 on inquiry card.

An unbeatable pyrometer for any range between -300° and +2800°F.

DYNALOG* ... the electronic potentiometer that has no slidewire!



This simple variable capacitor is important to potentiometer users because it eliminates the conventional, troublesome slidewire altogether; and it gives Dynalog Instruments the continuous *stepless* balancing which assures higher accuracy, closer control.

*Reg. U.S. Pat. Off.

TOPS in simplicity . . . unequalled in its combination of accuracy, sensitivity, and speed of response . . . the Dynalog Potentiometer with standard thermocouples gives you unerring temperature measurement for any range up to 2800°F. Featuring *sustained* accuracy of ¼ of 1% of scale, it's an instrument of laboratory precision built to withstand the severest industrial conditions.

Unprecedented freedom from maintenance is the direct result of unique Dynalog design. There's no slidewire, no battery to standardize. There are no gears, belts, or high speed reversing motors. There's nothing to wear and cause dead space.

Single pen recording models provide full scale pen travel in 3 seconds standard, or as fast as 1 second without extra cost. The Multi-Record Dynalog provides color-coded records of up to 6 points at 6 second intervals. Both types give the convenience and low cost of circular charts.

Dynalog Potentiometers are also used for the measurement of pH, oxidation-reduction potential, and for other applications in which the process variable can be converted to a dc millivolt signal. They are available for pneumatic or electric control.

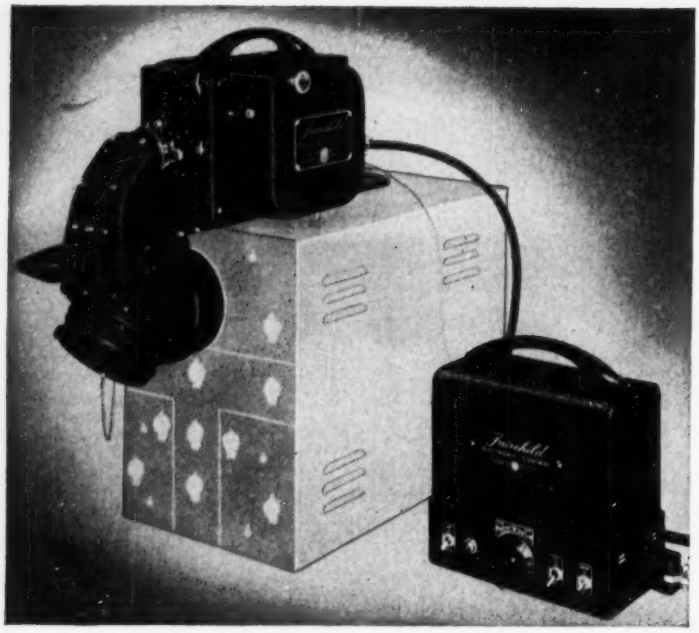
Write for your copy of Bulletin 427-1 which gives the whole story.

THE FOXBORO COMPANY, 466 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO POTENTIOMETERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle 19 on inquiry card.



YOU GET THESE ADVANTAGES

with the FAIRCHILD OSCILLO-RECORD CAMERA

DESIGNED FOR both still and continuous-motion photography on 35-mm film, the Fairchild Oscillo-Record Camera records non-recurring phenomena that are too rapid for visual study, others that are so slow that continuity is lost, and the occasions where very high-speed transients are combined with very slow-speed phenomena. Oscillo-Record camera users especially like these advantages:

1. POSITIVE FILM DRIVE—Film is sprocket-driven synchronously with the take-up spool to prevent slippage and jamming at high speeds.

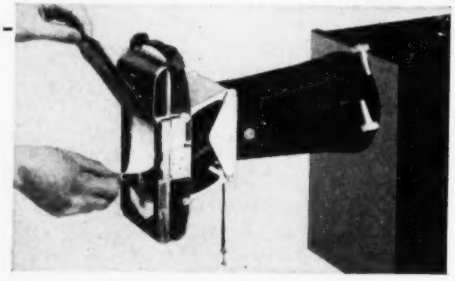
2. CONTINUOUSLY VARIABLE SPEED ADJUSTMENT—Film speed is electronically controlled over range of 1 to 3600 in. per min. No belts or pulleys are required.

3. TOP-OF-SCOPE MOUNTING—Controls are easily accessible. No tripod is needed.

4. VERSATILITY—Designed for both still and continuous-motion photography on 35-mm film. Provision for three lengths—100, 400, or 1,000 ft. For quick development and study of short lengths of film (up to 10 ft.) a special take-up cassette is available to help save time and reduce film wastage.

Fairchild-Polaroid® Oscilloscope Camera Provides Easy-to-Read Prints

For individual exposures the Fairchild-Polaroid Oscilloscope Camera provides speed, convenience, and economy. Trace reads normally—left to right. Reduction is exactly one-half size for easy measurement of values, especially with a grid. Each print is 3¼ x 4¼ and records two images.



One minute after you pull the tab, a finished print is ready for evaluation.

Complete information about applications and operation of the Fairchild Oscillo-Record and Fairchild-Polaroid Cameras awaits your request. Write today to *Fairchild Camera and Instrument Corporation, Robbins Lane, Syosset, Long Island, New York, Department 120-20F.*

FAIRCHILD
OSCILLOSCOPE RECORDING CAMERAS

For more information circle **20** on inquiry card.

TIE-IN WITH THE EIGHTH ANNUAL ISA CONFERENCE AND EXHIBIT CHICAGO, ILL. • SEPT. 21-25, 1953

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THE MAGAZINE OF MEASUREMENT • INSPECTION • TESTING • CONTROL

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Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE
LOSS OF FUEL ECONOMY
BAD COMMUNITY RELATIONS

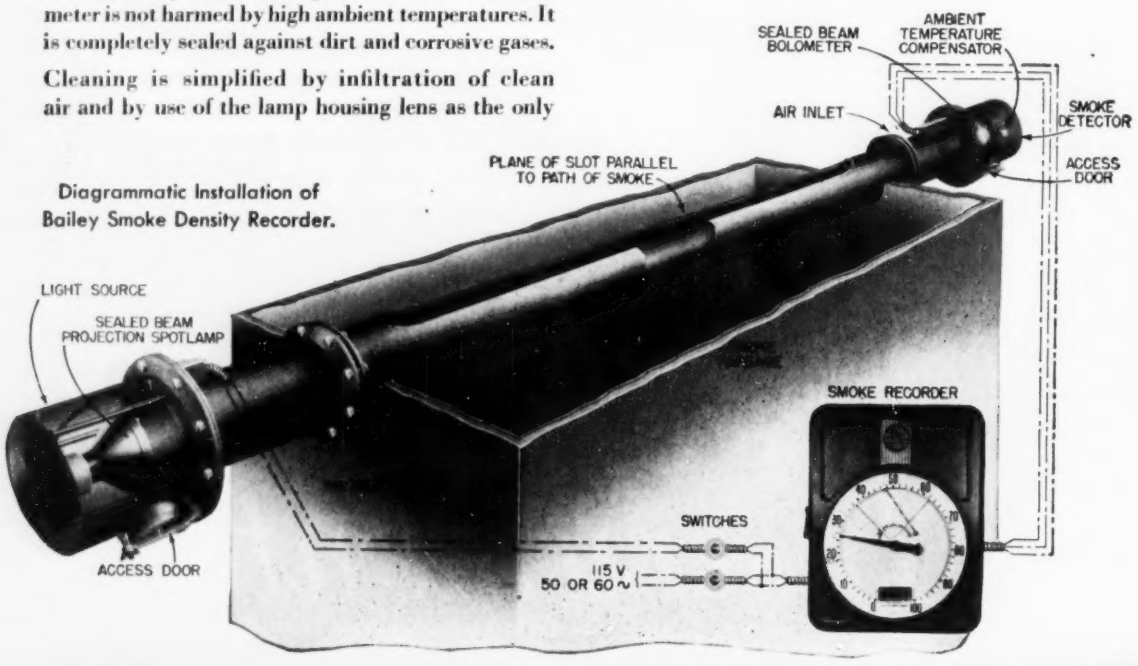
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

1041 IVANHOE ROAD, CLEVELAND 10, OHIO • BRANCH OFFICES IN PRINCIPAL CITIES

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

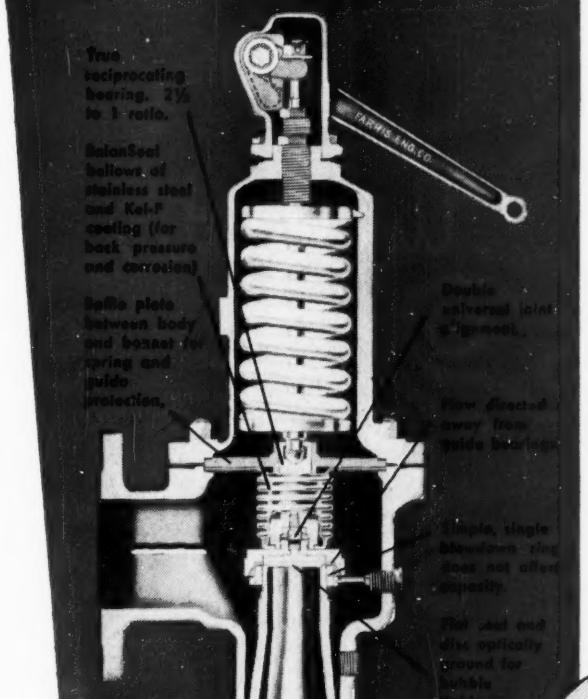
Let Bailey Smoke Density Recorders Watch Your Stacks

For more information circle 22 on Inquiry card.

for economical positive* safety...

BalanSeal and FarriSeal Safety-Relief Valves

(Pat'd & Pat. Pending)


True reciprocating bearing. 2½ to 1 ratio.
BalanSeal bellows of stainless steel and Kel-F coating (for back pressure and corrosion)
Baffle plate between body and bonnet for spring and guide protection.
FARRIS ENG. CO.
Double universal joint (Openset)
Flow directed away from guide bearings
Simple, single blowdown ring does not affect capacity.
Flat seat and disc optically ground for bubble tightness.

Eliminate all risk of failure—failure that might cost lives or severe damage to equipment. Rely on the only safety-relief valves guaranteed to provide positive protection, 100% of the time, under all operating conditions. Farris safety-relief valves *can't* stick, plug or corrode because the critical working parts are completely isolated from the lading fluid—and they're unaffected by back pressures in the discharge manifold. These unique valves are more economical, too, because they permit higher downstream pressure with smaller discharge piping. In many installations this saving in piping costs amounts to as much as 15 times the cost of the valves. *You* can't go wrong with BalanSeal or FarriSeal Valves because *they* can't go wrong!

Technical manual, 51B, a treatment on Back Pressure Piping and Surge characteristics and 76-page catalog is yours for the asking.

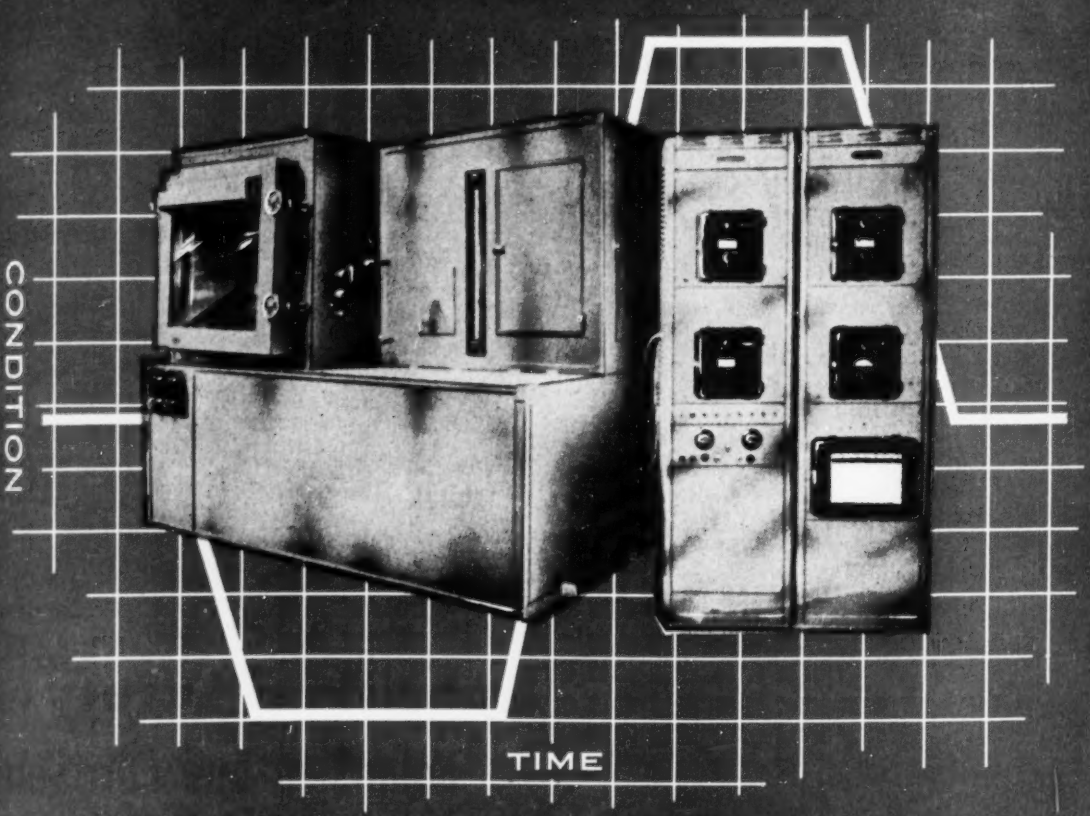
* ASME-N.B. APPROVED
(Certified for Capacity)

Representatives in all Principal Cities

Farris
ENGINEERING CORPORATION
610 Commercial Avenue
PALISADES PARK, NEW JERSEY

Affiliates: **Farris Flexible Valve Corp. • Farris Stacon Corp. • Farris HydroTorque Corp. • Farris HydroSeal Corp.**

For more information circle **23** on inquiry card.



Atmosphere Unlimited...

Automatic cycling chambers are being produced to accommodate from the smallest proximity fuses to the largest attack bomber in which it is a simple matter to duplicate the effects of exposure to conditions of pressure, temperature and humidity found any place on the face of the earth or to the highest altitudes reached by man.

This is but one of the many types of Merritt & Zaleski test chambers serving industry today. Both stock and custom-built models are available with virtually limitless ranges... low and high temperature, humidity, pressure and complete environmental duplication. Discover, without obligation, how Merritt & Zaleski can solve your particular testing problem. *Write in detail for an analysis and specific proposal.*

MERRITT & ZALESKI INC. ATMOSPHERE UNLIMITED

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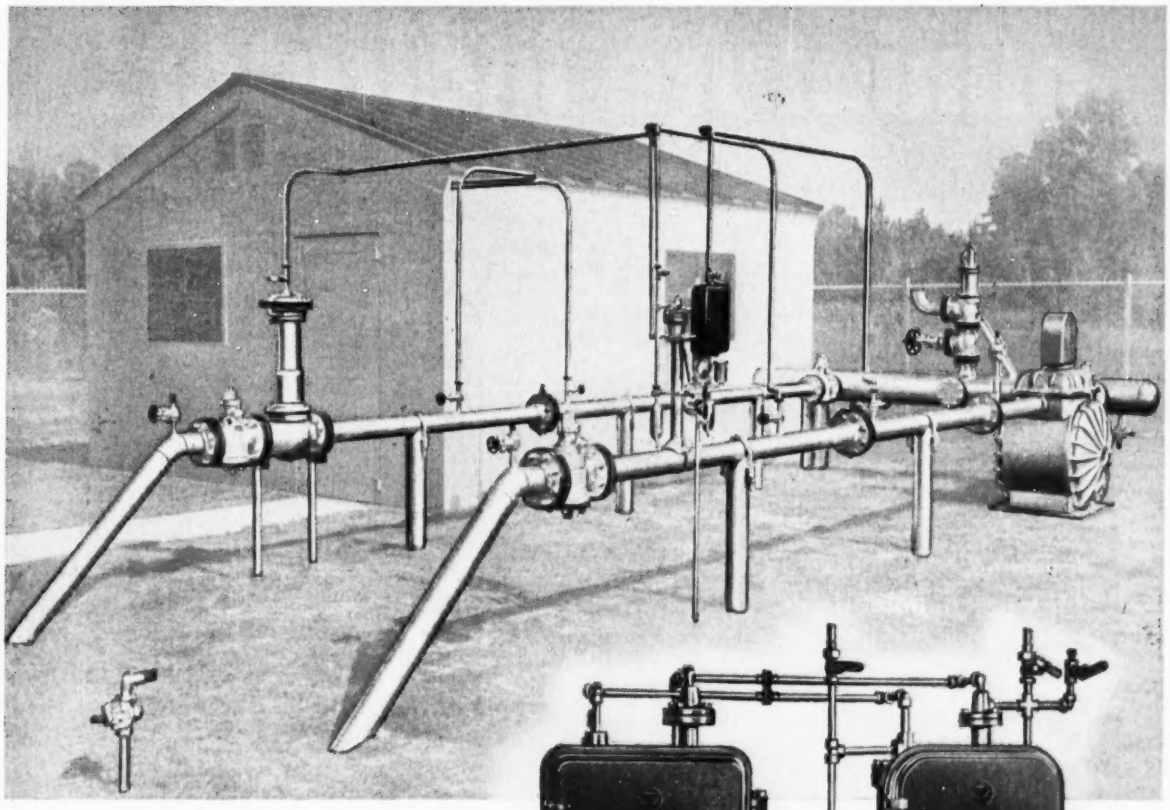
For further information circle 39 on inquiry card.

PRECISION GAS MEASUREMENT AT HIGH OR LOW FLOW RATES

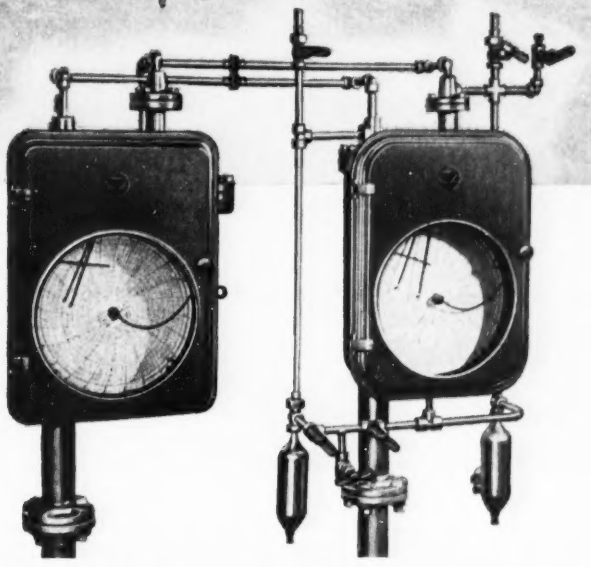


Southern Natural Gas Company Accurately Records Intermittent High and Low Volume Measurements.

Flow rates from zero to 154 thousand cubic feet of natural gas per hour are measured by this fully automatic measuring station.

An American® 500B, 250-pound Ironcase Displacement Meter measures flow rates up to 31,000 cubic feet per hour. Demand volume and meter pressure are recorded by a seven-day 100-pound American Volume and Pressure Gage.

A 100-inch Series A-88 American Differential Valve actuates a 4-inch Type CBVA Reliance Control Valve transferring approximately 80 percent of the flow to the orifice meter run when flow rates exceed the capacity of the Ironcase Meter.



This Duplex installation consisting of 20-inch — 100-inch Series A-88 American Westcott Orifice Meters records 80 percent of the flow at rates from 31 thousand to 154 thousand cubic feet at normal operating pressures of 50 pounds gauge pressure in the orifice meter run when used in the above combination with the 500B Meter.

AMERICAN® METER COMPANY
INCORPORATED ESTABLISHED 1836

AMERICAN METER CO. MFG. METERS SINCE 1836

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
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For more information circle 25 on inquiry card.

a new miniature indicator!

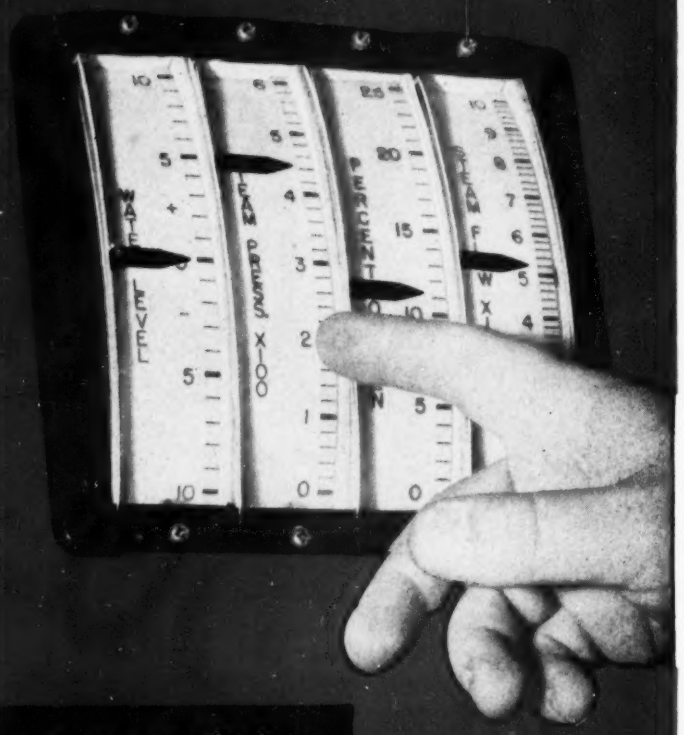
Available with:

MEASURED VARIABLE → AIR-PILOT → COPPER TUBING

PNEUMATIC TRANSMISSION

MEASURED VARIABLE → DIFF. TRANSF. → AMPLI-FIER

ELECTRICAL TRANSMISSION



removable units—interior illumination

easy to read—5 inch scale, no parallax

easy correlation of related functions

easy zero check from the front

HAYS Miniscale Gages

This miniature instrument is especially suited for remote indication of such variables as pressure, draft, flow or level.

The scale is only 5 inches long — easy to read — internally illuminated. Choice of pneumatic or electric transmission.

Also available is the Hays direct reading miniscale gage for indicating *pressures* of fluids (steam, water, gas, oil, etc.) directly.

Gages are arranged for flush or semi-flush mounting. Either a yoke mounting, for as many as 12 units, or a keyhole clamp mounting for individual units can be provided.

Write today for full information on the Hays Miniscale Gages Bulletin 52-1075-223.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

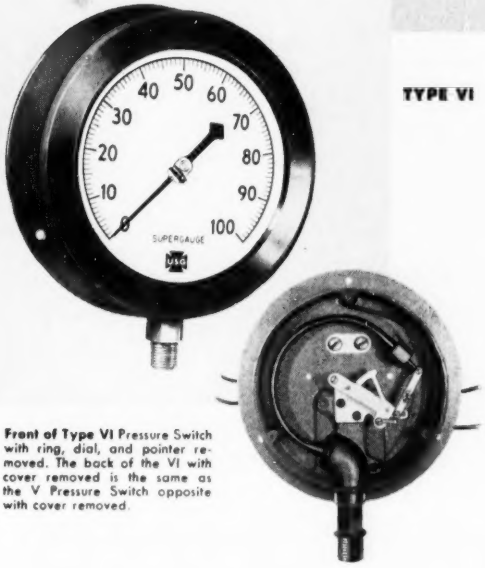
THE hays CORPORATION

MICHIGAN CITY 8, INDIANA

For more information circle **26** on inquiry card.

PRESSURE SWITCHES

• What they are • How they work • Where you use them



Front of Type VI Pressure Switch with ring, dial, and pointer removed. The back of the VI with cover removed is the same as the V Pressure Switch opposite with cover removed.

Type V Pressure Switch with cover removed.

The USG Type V Pressure Switch consists essentially of a pair of micro-switches making or breaking contact in response to a pressure-sensitive element (bourdon spring).

Type VI has the same switch-operating pressure element as Type V but it has an additional bourdon spring connected to a pointer so that pressure can be read on a dial.

Pressure switches are used wherever a pressure warning signal must be given. Typical applications are: hydraulic pumps, hydraulic presses, die casting equipment, or guarding or controlling high or low tank pressures.

For information relating to your problem, call the United States Gauge office in your city or get in touch with us at Sellersville. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

CONSTRUCTION

TYPE V Case:	Cast-iron case, back flange mounting, black crackle finish.
Size:	4½" case only
Bourdon Tube:	Beryllium copper or stainless steel
Pressure Connection:	Lower only: ¼" male N.P.T. up to 1000 lbs. pressure; ½" male N.P.T. for 1000 lbs. and over.
Electrical Connection:	½" female pipe conduit.
Pressure Ranges:	Up to 10,000 p.s.i., vacuum to 30".
Micro-switches:	High and low; rated 10 amps., 110 A.C., both fully adjustable over entire range of gauge.
Switching Differential:	3%. Switches are not affected by overpressure.
TYPE VI	Same case construction, micro-switches, switch-operating elements, switching differential, pressure connections, electrical connections, and pressure ranges as Type V. Case has dividing wall between the separate bourdon spring systems for operating the pointer and the micro-switches.
Dial Sizes:	4½" and 6"
Accuracy of Indications:	½ of 1% of the scale range.

Quality Gauges Engineered for Enduring Accuracy UNITED STATES GAUGE

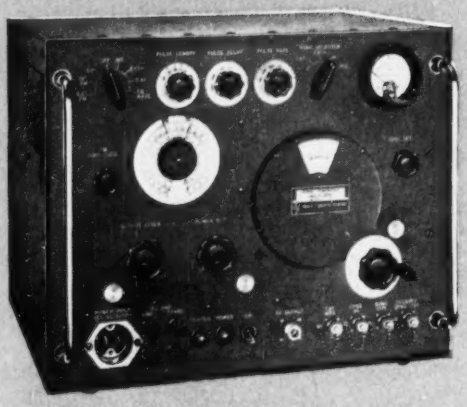
PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

For more information circle **27** on inquiry card.

ELECTRONIC TEST INSTRUMENTS

-hp- 612A—Versatile, direct reading; for UHF-TV or other work, 450 to 1,200 mc



-hp- 618B—Varied pulsing capabilities; direct reading, range 3,800 to 7,600 mc

Two new multi-purpose signal generators for faster, more accurate UHF, SHF work

Model 612A is a master oscillator-power amplifier signal generator especially designed for UHF-TV measurements. It is particularly useful in measuring receiver and amplifier gain, selectivity, sensitivity and image rejection. It is also a convenient direct-reading laboratory power source for driving bridges, slotted lines, antennas and filter networks.

DIRECT READING

Both frequency and output are directly set and read on large, precisely calibrated dials. No charts or interpolation are required. Maximum output is ½ volt into 50 ohms throughout range. The instrument has low incidental fm and broad band video modulation to 5 mc. It may be modulated internally or externally, amplitude modulated, or pulse modulated (good rf pulses 0.2 μsec or longer). Pulse modulation may be applied direct to the amplifier, or direct to oscillator for high on-off signal ratios.

Model 618B is designed for swift, sure component testing in radar, radio or relay TV carrier systems and similar applications. Frequency is generated in a reflex klystron oscillator; accuracy and stability are high throughout range. Frequency and voltages are directly set and read. Tuning is tracked automatically; no voltage adjustment is required during operation.

VARIED MODULATIONS

The instrument may be internally or externally pulse modulated, internally square wave modulated or frequency modulated. Repetition rate is continuously variable between 40 to 4,000 pps. Pulse width is variable 0.5 to 10 μsec. Sync out signals are simultaneous with the rf pulse or in advance from 3 to 300 μsec. Model 618B may be synchronized with an external sine wave, or with positive or negative pulse signals.

SPECIFICATIONS

-hp- 612A Signal Generator

Frequency Range: 450 to 1,200 mc, 1 band.

Accuracy: Calibration ±1%. Resettability better than 5 mc at high frequencies.

Output: 0.1 μv to 0.5 v continuously variable. Calibrated in volts and dbm. Impedance 50 ohms. Max. VSWR 1.2. Accuracy ± 1 db entire range.

Modulation: Amplitude: From 0 to 90% indicated by panel meter.
Envelope Distortion: 2% at 30% modulation.
Internal: Fixed modulation frequencies, 400 and 1,000 cps.
External: Any frequency 20 cps to 5 mc.
Pulse Requirements for External Modulation:
Pulse to Amplifier: Good pulse shape at 0.2 μsec length.
Pulse to Oscillator: 1.0 μsec minimum.

Size: Cabinet 12" x 14" x 18" deep.

Price: $1,200.00.

SPECIFICATIONS

-hp- 618B Signal Generator

Frequency Range: 3,800 to 7,600 mc. 1 band.

Calibration: Direct. Accuracy better than 1%.

Stability: Frequency: less than 0.006% per °C change.
Line Variation: ± 10 v causes less than 0.01% frequency change.

Output: 1 mw/0.223 v to 0.1 μv into 52 ohms. (0 to −127 dbm.)

Modulation: Internal and external pulse, fm, or internal square wave.

External Sync: (1) Sine wave 40 to 4,000 cps, 5 to 50 v rms.
(2) Pulse signals 40 to 4,000 pps, 5 to 50 v (pos. and neg.). Pulse width 0.5 to 5 μsec. Rise time 0.1 to 1.0 μsec.

Size: Cabinet 16¾" x 13½" x 16" deep.

Price: $2,250.00.

For complete details, see your -hp- field representative or write direct

HEWLETT-PACKARD CO.
2525C Page Mill Road, Palo Alto, California, U. S. A.
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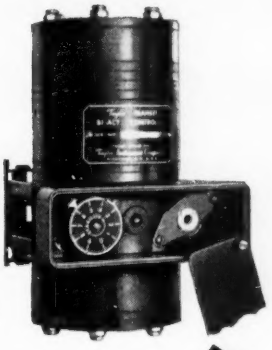
Instruments for Complete Coverage

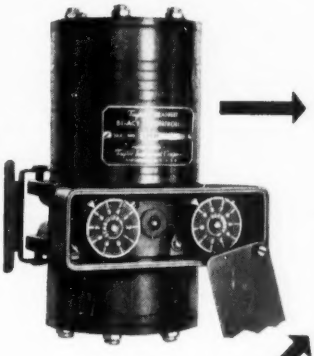
For more information circle **28** on inquiry card.

Plug-in feature fits all 3

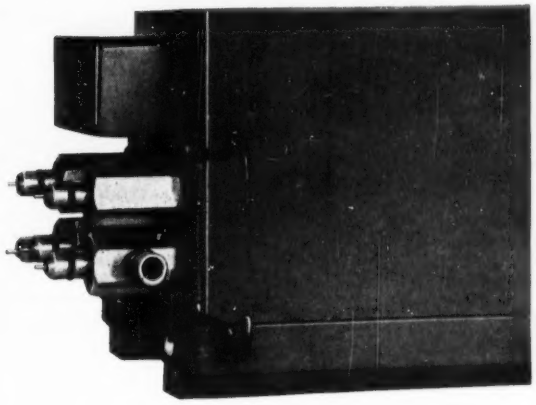


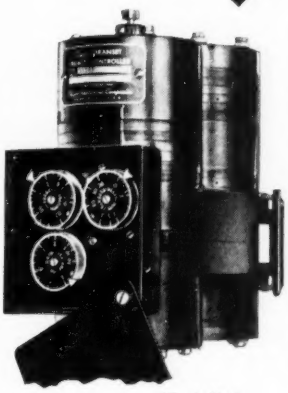
The one-knob BI-ACT Controller is designed for use in industrial processes with short time lags, such as close-coupled liquid flow, fast pressure and comparable temperature problems. Combines simplicity of adjustment and economy.

One-knob BI-ACT*, two-knob BI-ACT and TRI-ACT* Controllers completely interchangeable on TRANSET* Indicators, Recorders and field-mounted manifolds, thanks to universal PLUG-IN feature.



The two-knob BI-ACT Controller will cover the full range of reset rate and proportional response adjustments. This makes it more satisfactory for those jobs that have longer time lags, and where close response adjustments are essential to good performance.





The brand new TRI-ACT Controller combines all three response adjustments (gain, reset rate and Pre-Act response). It is the most complete controller, giving the very best control on the more complex processes, particularly those with long time constants, and load changes requiring both derivative and reset adjustments. Gives faster recovery on load changes; start-up without overpeaking; the benefits of automatic reset without its evils.

*Trade-Mark

Plug-in, Taylor's new idea in panel instrumentation gives you simplicity of installation and maintenance; economy in installation and in panel space; and minimum down time for maintenance.

You can change from the simplest to the most complete control, or from indicator to recorder or vice versa, by simply unplugging one unit, plugging in another—in a matter of seconds. Only one simple rectangular panel opening is required for mounting both controller and receiver (recorder or indicator). Does not require welding or drilling of holes.

Only 3 piping connections required: air supply, controller output and variable transmitter. All other connections are made automatically, in the self-sealing manifold.

Panel space is not only reduced by plug-in feature, but adjustments and maintenance are even more convenient.

Write for full information on Taylor Plug-In TRANSET Control—it may well be the answer to your problem. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Taylor Instruments mean ACCURACY FIRST

For more information circle 29 on inquiry card.

NOW... A NEW, COMPLETE ELECTRONIC PROCESS CONTROL SYSTEM

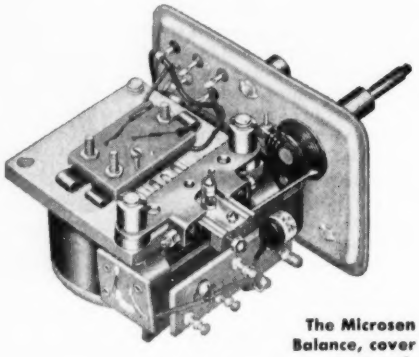
How to *improve quality of control and reduce capital investment* to obtain a given through-put are problems of vital importance in the process industries.

The American Electronic Process Control System — a new and complete electronic system — answers both problems in every respect. It utilizes all the advantages and superiorities of electric transmission of measurement and operational signals. It is the most efficient means ever developed for measuring and controlling temperature, pressure, differential pressure, liquid level and flow. Every requirement for accuracy, dependability, flexibility, low maintenance and convenient servicing is fully satisfied, because the American Electronic Process Control System provides:

1. Virtually no lag in signal transmission.
2. A degree of stability so high that narrower proportional bands can be used.
3. A degree of sensitivity practically impossible to duplicate in any other type of actuation.
4. Complete freedom from dirt, corrosion, leakage and freeze-ups.
5. Standardization of control components that permits interchange at the control panel, regardless of the type of variable under control.
6. Installation of all controllers right in the control house, any distance from the process area, because of the dependability and accuracy of electrical signal transmission.
7. Plug-in components in each instrument to simplify servicing.
8. Adaptability that permits more than one input circuit to be fed into a controller for cascading purposes, without using an additional relay.
9. Flexibility that makes it practical to feed the output signal in series to any number of receivers, without impairing accuracy.
10. Practically no investment in air compressors, filters, pressure regulators, or dryers and their maintenance.
11. Transducers for installation where a tie-in with pneumatic systems is required.
12. Suitability for service with analog and digital computational and print-out equipment for statistical and record purposes.
13. Multipoint-potentiometer type recording of all variables for permanent records.

Major instruments that make up the complete American Electronic Process Control System are pictured here. All are made by Manning, Maxwell & Moore, Inc., a company with more than a century of experience in manufacturing precision instruments for all industry.

Whatever your process control problem, we welcome the opportunity to demonstrate how the American Electronic Process Control System can improve the *quality* of your control and reduce the size and cost of process equipment for a given through-put. Your inquiry is invited. **Write for Catalog No. 164.**



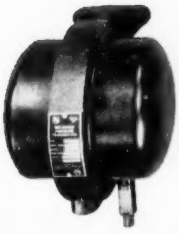
The Microsen Balance, cover removed.

THE MICROSEN BALANCE — a compact, modified Kelvin Galvanometer structure which operates on the force balance principle — is the "nerve center" of American Electronic Instruments. It has a rectified oscillator output of .5 to 5 milliamperes which serves as the transmission signal. The transmission of pressure, differential pressure, temperature, liquid level or flow information is practically instantaneous.

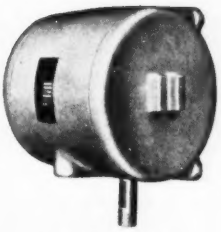
AMERICAN

1850 AMERICAN U.S.A.

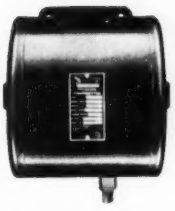
For more information circle 30 on inquiry card.



General Purpose Case

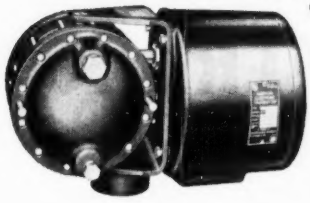


Explosion Proof Case



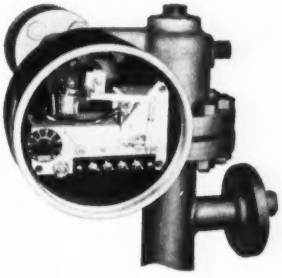
Vapor Proof Case

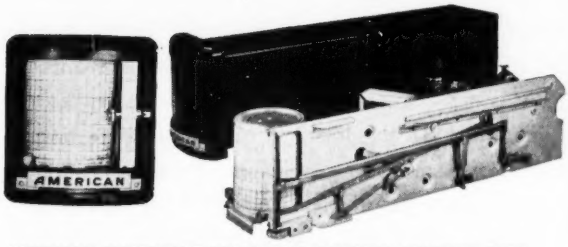
American Electronic Differential Pressure Transmitter with Barton Cell



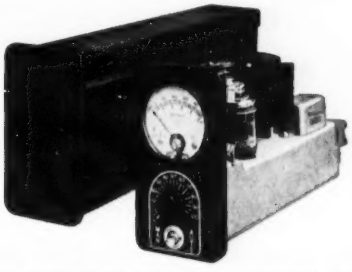
AMERICAN ELECTRONIC TRANSMITTERS are made in types to transmit temperature, pressure, differential pressure, liquid level or flow measurements. *Pressures* are measured by Bourdon tube or bellows elements; *differential pressures* by a Barton differential pressure cell; *temperatures* by standard thermocouples or thermostatic elements; *flow* by a Barton differential pressure cell; *liquid level* by a displacement type unit or a Barton cell. General purpose, vapor-proof and explosion-proof cases are available as required. **Write for Catalog No. 400A.**

American Electronic Transmitter with Displacement Type Liquid Level Instrument

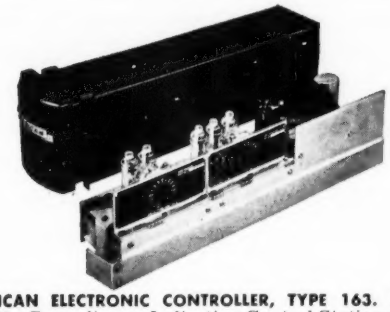




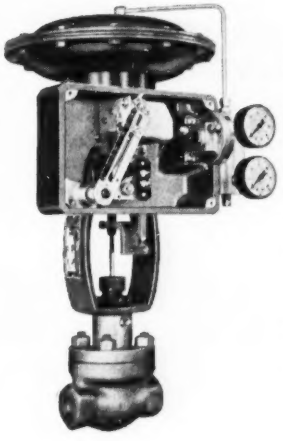
AMERICAN ELECTRONIC RECORDING CONTROL STATION, TYPE 162. A combination of two instruments: (1) a vertical scale card chart recorder which records the value of the process variable; (2) an adjustable set point which determines the control point of the Controller. Calibration of both instruments is indicated on a common scale. Motion of the recording pen is in a straight line; chart speed is ¼" per hour (one card in 24 hours). The American Electronic Indicating Control Station, Type 161, is available for applications where the recording feature is not desired.



AMERICAN ELECTRONIC MANUAL POSITIONER, TYPE 153MP. A regulated source of direct current suitable for remote loading of the electro-pneumatic valve positioner or the electro-pneumatic transducer. It is designed for use with the Type 163 Controller. Provision is made for switching between automatic and manual control without altering output current to the power device.



AMERICAN ELECTRONIC CONTROLLER, TYPE 163. Receives from the Recording or Indicating Control Station a voltage which is the output actuating signal. The output current thus automatically controls the manipulation of a process variable by means of the electro-pneumatic valve positioner or an electro-pneumatic transducer. In addition to proportional actions, *automatic reset* is provided to eliminate the effect that results from a process load change; also *rate action* to reduce the amplitude and duration of transient errors. When used with a manual positioning station, provision is made for "bumpless" transfer from automatic to manual.



AMERICAN ELECTRO-PNEUMATIC VALVE POSITIONER, TYPE 132C. Provides precision positioning of all standard pneumatically powered valves by an electric signal. May be used with either air-to-open or air-to-close valves. A split range model is available for sequential operation of 2 or 3 valves from a single transmission circuit. As an example of speed of response, in a valve having a final volume of 65 cubic inches, the time required to reach full stroke position is less than 3 seconds.

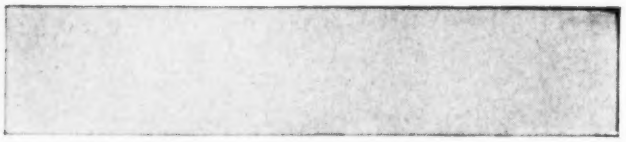
INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle 30 on inquiry card.

HAGAN



INSTRUMENTS AND CONTROLS

Whether your plans are to extend or modernize existing test facilities, or to build new facilities, the experience of Hagan in the fields of automatic control and instrumentation can be of extremely valuable assistance to you.

Our clients include the leading aeronautical testing laboratories of numerous governmental agencies, oil company research laboratories, United States Air Force testing facilities, and manufacturers in the aeronautical and automotive industries.

Installations have ranged from simple measurements of force, pressure or temperature to the complex systems of automatic control required for facilities to simulate flight conditions.

In analyzing each project, the engineers of our Aeronautical Division can choose equipment to suit the specific requirements. They can use pneumatic, hydraulic or electronic systems, in any combination. Hagan recording, indicating and integrating instruments, signal transmitters and a complete series of Hagan control devices are available for combination into a system which will achieve the desired results.

For more information circle 31 on inquiry card

for RESEARCH-DEVELOPMENT PRODUCTION

The scope of Hagan's activities can be judged from this partial list of successful installations:

Automatic control systems for subsonic and supersonic wind tunnels.

•

Automatic control systems for accessory and component test facilities.

•

Automatic control systems for steady state, blowdown and trajectory tests in turbojet, turboprop and ram jet test facilities.

•

Automatic control systems for burner stands.

•

Automatic control systems for parallel and/or series operation of blowers and exhausters.

•

Programmed control systems for simulated flight conditions and trajectory tests.

•

Automatic controls for gas turbines.

•

Automatic control of pressure, pressure ratio, temperature and mass flow.

•

Constant weight control for blowers.

•

Surge control for blowers.

•

Direct reading mass flow meters for both air and fuel, with automatic correction for variable pressure, temperature and density.

Automatic resolution of multiple wide range correction factors into a single correcting signal.

•

Measurement and automatic control of gas flow ratio.

•

Automatic totalizing of gas or liquid flow rates, using electronic, pneumatic or mechanical systems.

•

Direct reading Mach meters.

•

Measurement and automatic control of liquid flow, with automatic correction for gravity or density.

•

Measurement and control of gas flow, with automatic correction for pressure and temperature variation.

•

Differential pressure control and recording.

•

Cradle dynamometer load and torque measurement.

•

Jet engine and rocket thrust measurement.

•

Portable thrust stands for aircraft thrust measurement.

•

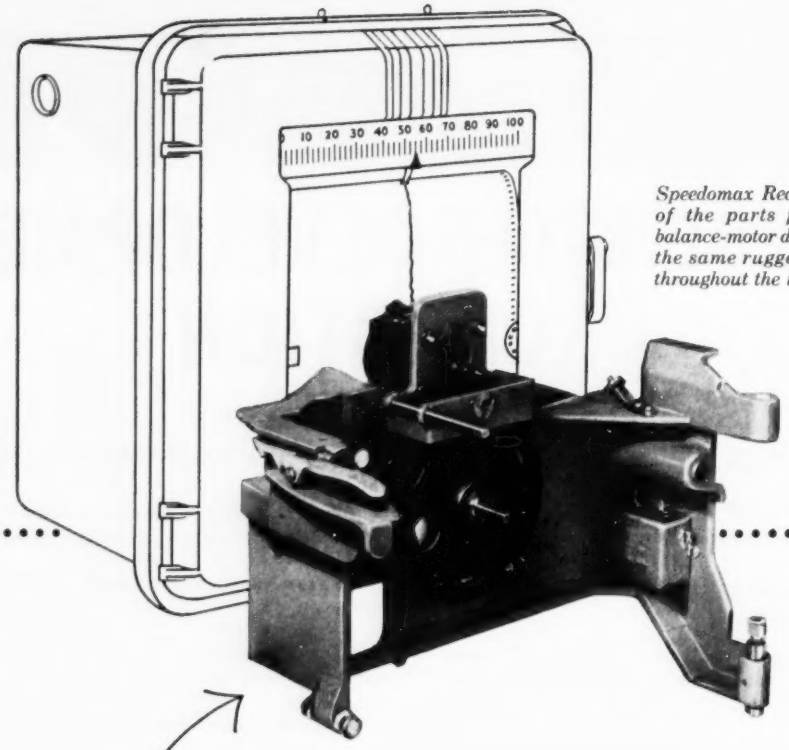
The resources of our Aeronautical Division are at your service when extensions or additions to your testing facilities involve problems kindred to those listed above.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION
AERONAUTICAL AND SPECIAL PRODUCTS DIVISION
HAGAN BUILDING, PITTSBURGH, PA.

DISTRICT OFFICES IN ALL PRINCIPAL CITIES

For more information circle 31 on inquiry card.



Speedomax Recorder and a few of the parts for its circuit-balance-motor drive. You'll find the same rugged construction throughout the instrument.

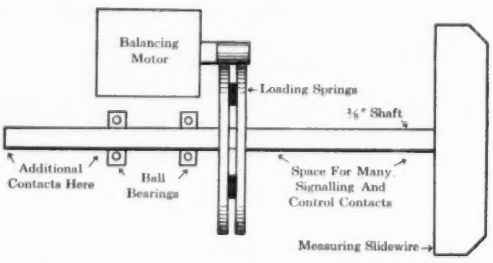
RIGID CONSTRUCTION MEANS Rigid Dependability

● When you turn a measuring or control job over to a Speedomax instrument, much of the good performance you receive is due to the strong, carefully-assembled mechanism controlled by the sensitive electronic circuits. Seasoned, time-proved mechanical design is evident as soon as you open the instrument door.

For instance, just rotate the "big" balancing-gear train with your fingers. You won't detect back-lash. The train will turn at a touch, but those two 1⅛" face, spring-loaded gears are held so snugly against the pinions, in opposite directions, that they answer every tiny balancing motion in either direction. The slightest nudge from the "huge" 12-watt balancing motor therefore goes straight to the slidewire, recording and control mechanism via their common shaft. The tying of these functions to one shaft assures permanent alignment of recording, control and measuring functions.

The paper drive and some other components get their positive action in another way. They use machined, heat-treated worm gearing for snug fit and precise motion. Ability to use such designs is one of the many advantages of the instrument's ample power. Liberal use of ball bearings is another quality feature, to transmit full power, reduce routine attention and maintain operating precision.

As you look further into a Speedomax, you'll also note that many parts such as frame castings, shafts, linkages, etc., seem very large. But there's a strong reason for this seeming oversize—it prevents mechanical deflections in operation. Rigid construction gives rigid dependability.



The Speedomax Mechanism "Heart" Is Just 2 Assemblies

Why not inspect these and other evidences of quality the next time you need an electronic potentiometer or bridge. You can easily check them against the general description in our Catalog ND46(1). If you're interested in research, ask also for Technical Publication ND46(1). Address our nearest office, or 4955 Stenton Ave., Philadelphia 44, Pa.

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For more information circle 32 on inquiry card.

Editorial Comment

"Electronic" vs. "Electric"

A favorite subject of discussion on editorial pages of technical publications is the question of the difference between "electric" and "electronic" devices.

One new and extreme definition of electronics proposed recently by Dean W. L. Everitt (see *Instruments*, Nov., 1952, p. 1525) would have made all instruments "electronic." Mr. Fred Lichtgarn, known to readers of *Instruments* as inventor and author in the field of water-vapor measurement, submits the following definition: "Electronics is the science of utilizing effects produced by circuits, apparatus and devices which incorporate electron flow in, or through, or in association with, mediums normally considered to be insulators."

The definition we adopted ten years ago is the one written by Dr. Joseph Slepian: "An electronic device is one in which electric conduction current is carried through a vacuum or gaseous space."

Mr. Lichtgarn's definition would make a capacitor "electronic." Dr. Slepian's definition does not encompass the new solid-state semi-conductor devices. Hence a combination of these definitions may be the answer to the perplexing question. The following Slepian-Lichtgarn-Aronson definition is thus presented for consideration and discussion:

"An electronic device is one in which electric conduction current (free electrons, holes, or ions) is carried through, or utilized in, mediums normally considered to be insulators."

This definition makes a capacitor nonelectronic because the current through a capacitor is displacement current, not conduction current. Also, it includes the new solid-state devices in the "electronic" category.

Instrumentation Needs in Middle-Western Industry

The Midwest Research Institute, a non-profit research organization located in Kansas City, Missouri, is conducting a survey to develop the following information: (1) determine the existing level of instrumentation by industrial groups in Iowa, Nebraska, Kansas, Missouri, Arkansas and Oklahoma, (2) compare that level of instrumentation to the national level and to the level in other representative industrial areas, (3) determine the general areas where increased instrumentation can contribute toward reduced operating costs, toward reduced investment in proposed expansion, toward increased plant safety and toward increased quality of product out put.

Information on sales of instruments, on percent of equipment capital invested in instruments, and on particular problems which could be solved by instrument application is requested from all instrument users and manufacturers who desire to assist this survey. Anyone wishing to remain anonymous may do so. A questionnaire will be sent on request—or, answers to the following questions can be sent directly:

(1) Approximately what percent of your plant equipment investment is directly involved in instruments and control systems? (2) What are your principal products? (3) What is your dollar volume of production per year? (4) What is your production in terms of tonnage or items? (5) What percent of your production operations are conducted by automatic control methods? (6) How many production workers do you have at present? (7) How many persons are directly involved in instrumentation either in operation or maintenance? (8) Please indicate roughly the number of various production control and inspection instruments in your plant. (9) *This is the jack pot question!* What are your specific and immediate problems in production which might be solved by proper instrumentation if available? (10) Remarks or suggestions.

Address all information or inquiries to: Midwest Research Institute, 4049 Pennsylvania Avenue, Kansas City 11, Mo. Attention: Mr. Charles E. Hansen.

Evolution of a Mechanic

CHICAGO, ILL.—The illustrations of the course in "Modern Automative Servicing" given by Sun Electric Corp. of Chicago, Ill. show liberal use and emphasis on instrumentation. The significance of the pictures is more than is realized

at first glance. Instruments can raise the standards and efficiency of any profession. Instruments can make it possible for the car mechanic of today to become the automotive repair engineer of tomorrow. Thus is technical progress—in all fields—rooted firmly in instrumentation.

Owing to moving the office of the Instruments Publishing Company to new and larger quarters,

THE 1954 INSTRUMENTS INDEX

will appear in August (instead of July as announced).

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 929

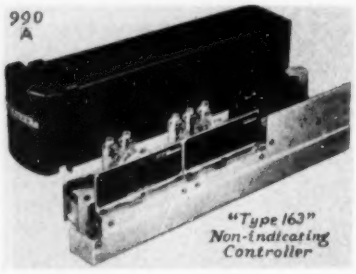
Gas-stream Analyzer

New as a commercially-available instrument is "Titrilog" which heretofore was available only on a lease basis. Now, it can be either leased or purchased.—*Consolidated Engineering Corp., Pasadena 8, Calif.*

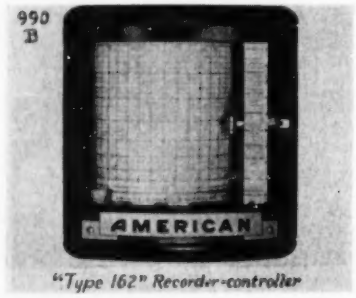
For more information circle 201 on inquiry card.

Process Control System

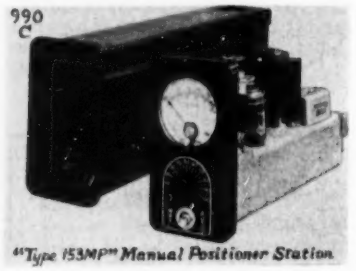
New "American Electronic Process Control System" features lagless transmission of signals, is claimed to



be "the most efficient means ever developed for measuring and controlling temperature, pressure, differen-



tial pressure, liquid level, and flow. . . . Narrower proportional bands can be used with sensitivity impossible

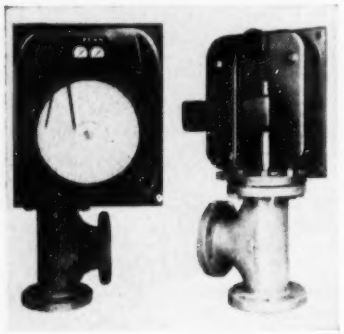


to duplicate in any other type of actuation."—*Manning, Maxwell & Moore, Stratford, Conn.*

For more information circle 202 on inquiry card.

Variable-area Flowmeter

New model of "Linameter," variable-area type flowmeter, is furnished with pneumatic transmission. Instru-

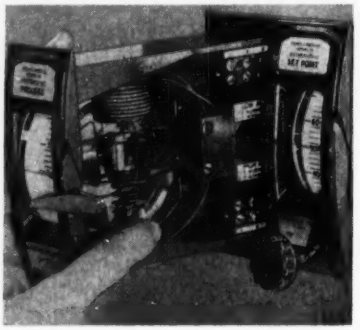


ment is fundamentally linear and air output signal varies directly with flowrate. (Output range 3-15 psig. standard, other ranges available). It operates on rotameter principle; is mounted directly in pipe line like a valve; is produced in sizes from 2 in. to 8 in. with a wide choice of materials. Coupling between metering float inside flow stream and instrument components outside is magnetic (no stuffing boxes or pressure-tight bearings) and completely frictionless. Instrument is particularly suitable for hazardous areas: entirely explosion-proof, no electric power required. —*Penn Industrial Instrument Corp.*, 4110 *Haverford Ave., Philadelphia 4, Pa.*

For more information circle 203 on inquiry card.

Remote Miniature Indicator

New "Ratographic" indicator (first in maker's series of "Ratographic" miniature instruments) is suitable for mounting in either graphic or conventional panels, has a total scale length of 5.75 in., graduated from 0 to 100. Scale is mounted on a rotat-

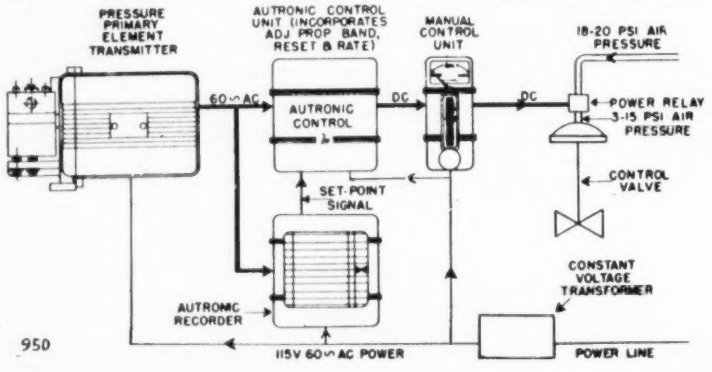


ing drum, is positioned by a pneumatic signal from any remote primary or secondary instrument, rotates just behind a fixed horizontal reference line, can be read with precision consistent with instrument's accuracy of 0.5 percent of full-scale. Feature is variety of visual and audible alarm devices and operating guides that can be incorporated. Indicating color guides and alarm contacts can be reset to monitor any scale portions without operating the system or pressurizing the indicator. Explosion-proof pneumatic alarms are available. Instrument can be furnished with an integral pressure reg-

Automatic-control Systems

New "Autronic packages" are announced, both built around basic components of "Autronic Control System" previously announced: (1) Recording package comprises "Type P2T" pressure primary element transmitter, "Type A2R" recorder, and a constant-voltage transformer; (2) controlling and recording package includes these items plus a "Type A3C" controller with proportional band and automatic reset, "M2C" manual control, and "P2R" power relay.—*The Swartwout Co.*, 18511 *Euclid Ave., Cleveland 12, Ohio.*

For more information circle 204 on inquiry card.

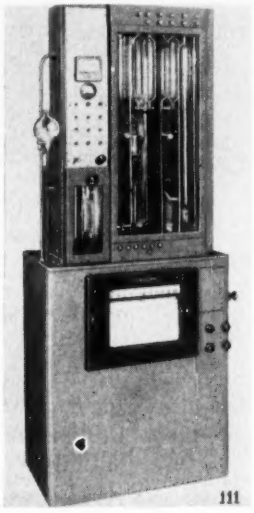


ulator by which an operator can manually reset a remote controller or other controlling device. Two of these new indicators, when combined with a loading regulator, transfer valve, and gage-function switch, may be mounted side-by-side to make up an indicating control selector station. Three different functions can be followed with a pair of indicators combined with standard components. New instrument can be removed from panel by pulling it from its case, since all electrical and pneumatic connections are of plug-in-type and pneumatic signal line seals itself with a ball check valve.—*Fischer & Porter Co., 11 Jacksonville Rd., Hatboro, Pa.*

For more information circle 205 on inquiry card.

Hydrocarbon Gas Analyzer

New "Fracton," for rapid semi-automatic analysis of hydrocarbon



111

gases, performs analyses of hydrocarbon mixtures in from one to three hours.—*Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.*

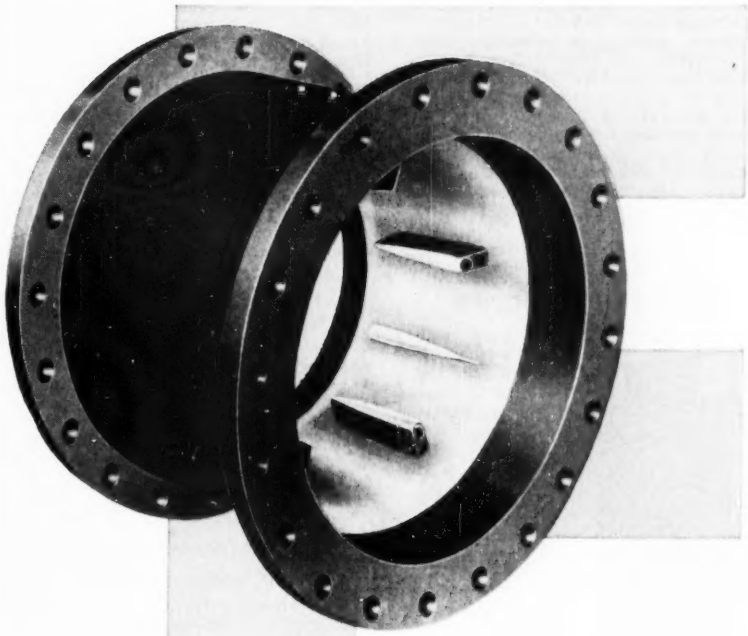
For more information circle 206 on inquiry card.

Mass-flow-rate Meter

New "Massometer," designed particularly for measuring free-flowing solid materials such as grain, flour, dry chemicals, etc., measures mass rate of flow by determining torque

991

FOR OVERALL ECONOMY



CHOOSE A FLOW TUBE

Flow Tubes offer economies all through their long service lives.

First cost is low. Installation costs are low, too, because Flow Tubes can be installed inside the plant. They are short, compact, and require only minimum straight runs entering and following. No expensive vaults are needed.

Operating costs are low. They require little, if any, maintenance. Pumping costs are low because Flow Tubes are available in types and D/d ratios to handle a wide range of fluids and main line velocities. This enables you to use the one Flow Tube that will produce differentials that can be accurately measured, with the least head loss.

All Flow Tubes are furnished with head capacity curves obtained in laboratory tests, and can therefore be guaranteed as to accuracy.

That's why Flow Tubes are being successfully used in scores of installations metering the flow of liquids and wet or dry gases. Available in all pipe sizes and suitable metals. They can be furnished with or without suitable secondary indicating, recording or totalizing instruments. For further information, write for your Flow Tube Data File. For specific recommendations, send us necessary flow data.

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FOSTER ENGINEERING COMPANY · UNION, N. J.

For more information circle 33 on inquiry card.

produced in accelerating flow (Coriolis effect). Torque is measured by a pneumatic force-balance system; conventional pneumatic receivers indicate, record, and totalize flow-rate in pounds per minute. Maximum capacity of present model is 225 lbs./min.; accuracy is 1 percent from 10 to 100 percent of capacity. Unit is 24.5 in. high by 26 in. wide; is arranged for pipe stand mounting: inlet and outlet fitted for 5-in. spouts.—*Wallace & Tiernan, Box* 178, *Newark* 1, *N. J.*

For more information circle 207 on inquiry card.

Methane Detector and Alarm

New combination analyzer and alarm continuously samples atmosphere of coal mines for methane gas, displays signal and sounds alarm when predetermined concentration is present in sample. Can be arranged to sample from several locations; may be equipped to provide a continuous chart record of methane concentration.—*Mine Safety Appliances Co., Pittsburgh* 8, *Penna.*

For more information circle 208 on inquiry card.

Electrometric Titration Instrument

New "Ampot" portable electrometric titration instrument is vibration-insensitive; has polarizing circuit

comprising a 3-volt dry-cell-powered voltage-divider network. Dial reads directly in millivolts per volt span applied to cell terminals. Current is indicated by microammeter with range multipliers. "Ampot" is suited to amperometric titration with dropping-mercury electrode as well as to other common types of metal-electrode titrations.—*E. H. Sargent & Co.,* 4647 *W. Foster Ave., Chicago* 30, *Ill.*

For more information circle 209 on inquiry card.

Continuous Hydrogen Analyzer

New hydrogen analyzer, said to be the first continuous-measuring, is based on principle of catalytic oxidation of hydrogen in a thermally-isolated reaction cell; measures hydrogen gas concentration present in hydrocarbons in any range up to 100 percent. Accuracy is 0.5 percent. Temperature differential in reaction cell is measured by two sets of thermopiles and relayed either to a chart recorder or to a direct digital printer.—*Taller & Cooper, Inc.,* 75 *Front St., Brooklyn* 1, *N. Y.*

For more information circle 210 on inquiry card.

Conductivity Bridges

New dual range "Solu Bridges" provide wider coverage: "RD-251" has two concentric scales calibrated 1-500 and 20-10,000 micromhos specific conductance; "RD-681" covers 1-300 and 20-6000 ppm NaCl.—*Industrial Instruments,* 89 *Commerce Road, Cedar Grove, N. J.*

For more information circle 211 on inquiry card.

High-pressure Conductivity Cells

New conductivity cells for high pressure applications are available in cell constants from 0.0100 to 0.200; are tested to withstand 6000 psi. cold water. Materials: stainless steel, high-density ceramic and nickel electrodes.—*Industrial Instruments, Inc.,* 89 *Commerce Road, Cedar Grove, N. J.*

For more information circle 212 on inquiry card.

Wet Test Meters

New rotating-drum gas and air meters of precision grade for heat value determination, calibration of flow

measuring devices, etc., are calibrated against Bureau of Standard Certified Bottles; are made in brass, Monel, or stainless steel; removable back for ease of cleaning and repairing when used on dirty and corrosive gases. Available in sizes from 10 to 1200 cu. ft. per hour.—*Labline, Inc.* 217 *N. Desplaines St., Chicago* 6, *Ill.*

For more information circle 213 on inquiry card.

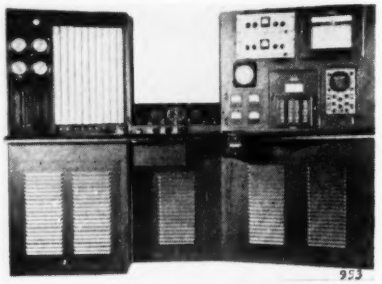
High-purity Carbon Rod for Spectrographic Analysis

New "Grade PG4" high-purity spectrographite rod for critical chemical and metallurgical spectrographic analysis is announced. Maker states that whereas normal graphite electrodes contain impurities on order of 0.02 to 0.05 percent, new rod has less than 0.001 percent.—*Stackpole Carbon Co., St. Mary's, Penna.*

For more information circle 214 on inquiry card.

Remote-control Consoles

New test and operating consoles for remotely monitoring and controlling engine test cells, hazardous proc-

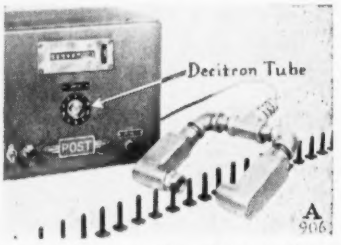


esses, etc., include instruments of purchaser's own choice. Illustration shows a military engine-test console with a 10-manometer bank, a 48-temperature indicator, a CRO, etc., also command levers and switches.—*Control Engineering Co.,* 8900 *Alpine Ave., Detroit* 4, *Mich.*

For more information circle 215 on inquiry card.

Electronic Counters and Preset-count Controllers

New "Decitron" high-speed electronic counters and automatic count controllers are built around "Decitron Counter Tube," a new type of cold-



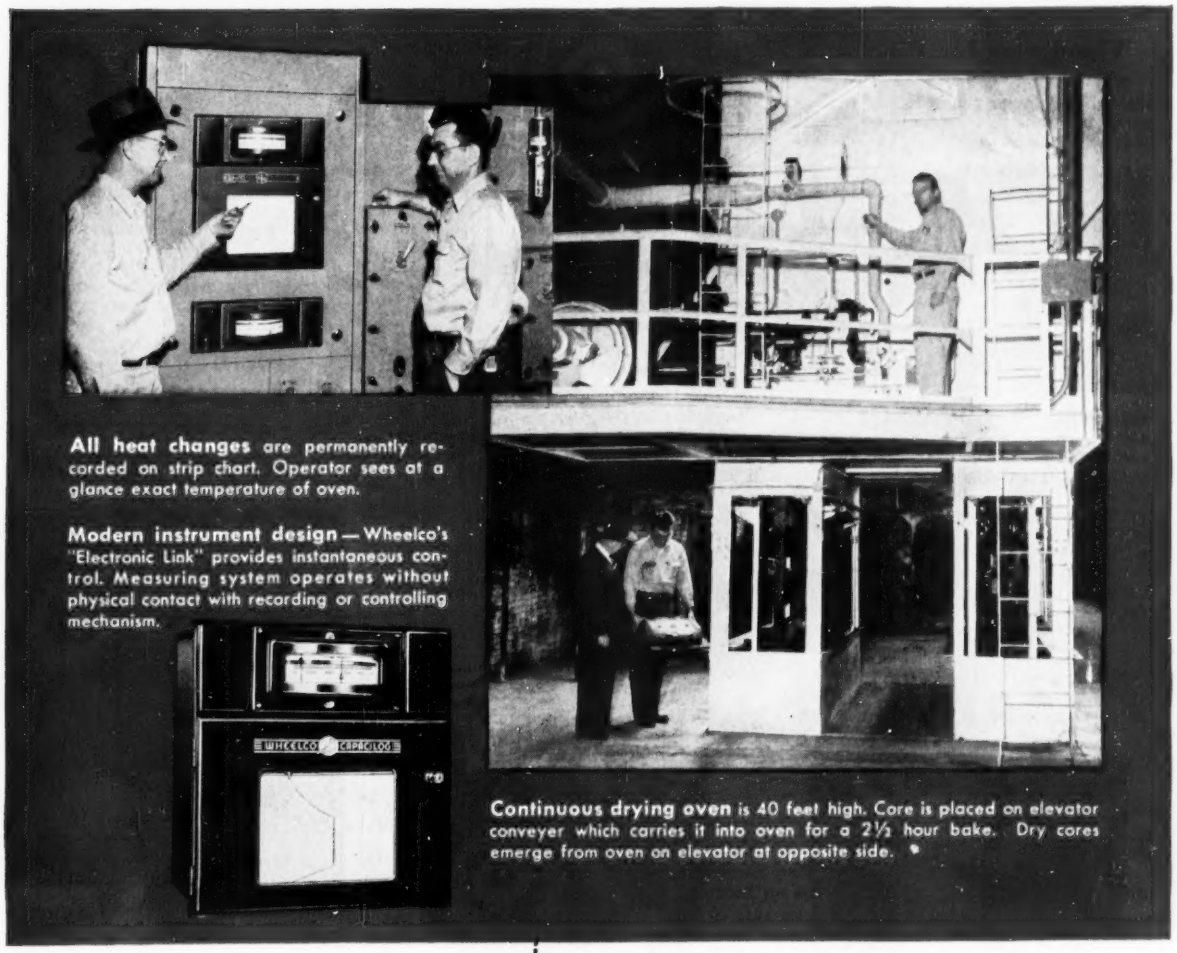
cathode electron tube which indicates units by a light beam advancing clockwise, which eliminates about half the working parts of ordinary electronic counters, and which has a normal life

BARBER COLMAN

Wheelco Instruments

...control continuous bake in modern foundry TOWER core oven

Wheelco Instruments maintain uniform temperatures in new Tower core oven at Falk Corporation. In this continuous drying operation, cores are placed in a slow-moving elevator conveyer, move up into the oven and 2½ hours later emerge below on the other side. The Wheelco Capacilog Strip Chart Recorder controls and maintains constant record of the oven atmosphere while the Wheelco Panelmount Capacitrol acts as excess temperature limit control. Operator gets continuous, accurate picture and permanent record of operations inside oven. Cores are bone dry at completion of heating cycle. There's no costly overshooting of temperatures. No waste fuel. It pays to modernize with Wheelco Instruments!



All heat changes are permanently recorded on strip chart. Operator sees at a glance exact temperature of oven.

Modern instrument design—Wheelco's "Electronic Link" provides instantaneous control. Measuring system operates without physical contact with recording or controlling mechanism.

Continuous drying oven is 40 feet high. Core is placed on elevator conveyer which carries it into oven for a 2½ hour bake. Dry cores emerge from oven on elevator at opposite side.

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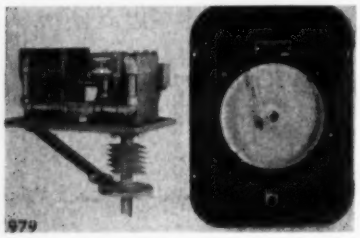
For more information circle **34** on inquiry card.

expectancy ten times that of conventional radio tubes. Five instruments are announced: (1) "Single Decitron Counter" (Fig. A) counts up to 20 units per second and can actuate an external circuit at each ten counts. (2) "Double," up to 200 per second and (3) "Triple," up to 2000 per second, also with external-circuit command feature; (4) "Decitron Carton Counter" (Fig. B) has selector switch for counts of 5, 10, 25, 50 and 100, operates external circuit at any number from 1 to 100, has Rate-meter feature. (5) "Preset Decitron Counter" has two selector switches, one for units and one for tens, can be manufactured to count up to a million or more. All counters have six-digit reset totalizer. Rate-meter can be incorporated in any model.—*Post Machinery Co., 140 Elliott St., Beverly, Mass.*

For more information circle 216 on inquiry card.

Viscometer for Reactors

New Viscometer specifically designed for large reactors is particularly suitable for following rapid polymerization processes; meets re-

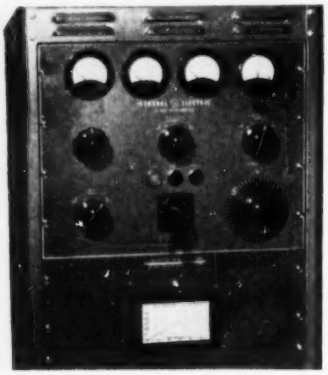


quirements of Federation of Paint and Varnish Production Clubs (November 1952 *Official Digest*). Measuring element is flange-mounted directly on top of reactor; complies with Underwriters' requirements for Class 1 Group D locations; is designed for a wide range of pressure and vacuum conditions.—*Dept. N27, Norcross Corp., Newton 58, Mass.*

For more information circle 217 on inquiry card.

X-ray Photometer

New "504E-351G1" x-ray photometer is more compact than maker's previous models; has all controls cen-

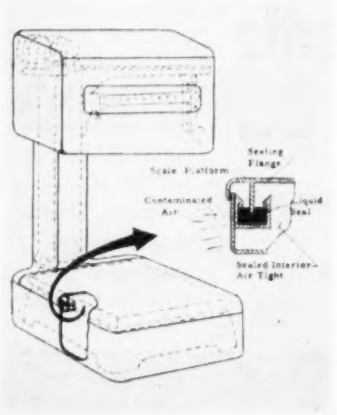


tralized on one panel; features an air-cooled x-ray source; can be operated with accuracy by a technician.—*General Electric Co., Schenectady 5, N.Y.*

For more information circle 218 on inquiry card.

Industrial Scale Seal

New "Cunningham Scale Seal" fits over standard models of weighing scales, protecting them from foreign



matter and corrosion. Sealing flange is fixed continuously around underside of moving platform; thus an air-tight liquid seal is effected at all times, irrespective of weight applied to scales. Column and head are also completely enclosed, with access door and windows for settings and readings. Entire device is "take-down" to permit inspection of scales required by some states.—*Applied Engineering Co., P. O. Box 506, Orangeburg, S. C.*

For more information circle 219 on inquiry card.

Volumetric Feeder

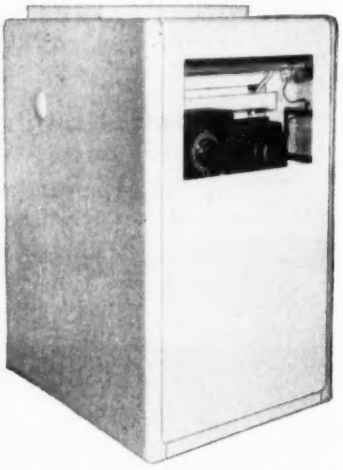
New "Model 50 Vitamiser Disc Feeder," for feeding small quantities of dry materials such as vitamin concentrates and mineral supplements,

has uniform rate of feed maintained by a 40-watt synchronous motor driving slow-moving disk. Feed rate is set by a micrometer gate adjustment knob. Accuracy of 3 percent by weight over a 20-to-1 range is obtained. New flat disk feeding mechanism features controlled angle of repose of material which assures uniform volumetric feeding.—*Omega Machine Co., 345 Harris Ave., Providence, R. I.*

For more information circle 220 on inquiry card.

Loss-in-weight Feeder

New "Model GLW-0" is a new small-size gravimetric feeder for plants where low rates of feed, limited floor

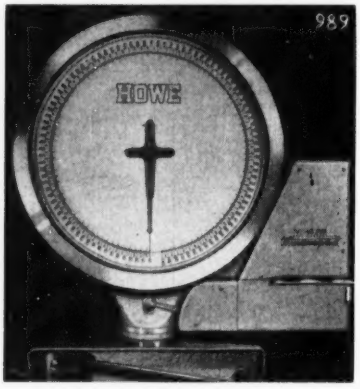


space and low-cost equipment are essential factors. It requires 26 x 33 in. floor area and 25 in. front and back for door clearance; is accurate to 99 percent or better, delivering powdered, granular or lump material at feed rates from 0.25 to 100 pounds per hour set by a single dial. No calibration is required; operation is dustless.—*Omega Machine Co., 345 Harris Ave., Providence, R. I.*

For more information circle 221 on inquiry card.

Weight-printing Recorder

New "Mechanoprint" is a simplified mechanical weight recorder, built-in as an integral part of maker's "Tape-Drive Dial" head. A touch of push bar



causes weight to be printed in just one second. Printing can also be controlled by a trip switch on a conveyor line, on a monorail system, etc. It is furnished for standard straight ticket, for ticket and tape, for odd-size tickets and with identifiers, manual or electric time and date stamp, consecutive numbering devices, etc.—*The Howe Scale Co., Rutland, Vt.*

For more information circle 222 on inquiry card.

Time Switches

New improved design of "300 Series" time switches incorporates improvements in terminal block; re-

For more information circle 35 on inquiry card. ⟶

NEW

Ratographic* miniature indicators

- Graphic indication of process limits
- Flange-to-flange flush mounting
- Fully interchangeable in seconds
- Drum dial, linkless mechanism
- Fixed reading-point improves speed of scanning
- Scale-set adjustable high/low operating guides and alarms
- Plug-in unit easily removed with finger jack for check or change

Completely described and illustrated in Catalog 55-10. Write for it today.

Fits panel space only 2⅜" x 5⅜"
yet with 5¾" long, readable
scale in keeping with ½% accuracy.
Unique, new "graphic guides" mark high/low operating range, are adjustably mounted on scale drum and carry switch trippers to actuate alarms or take emergency action. Rotating drum dial and fixed reading point permit large, easily read figures and open, uniform scale. Building block construction of Ratographic indicators permits field addition of alarms and guides to the basic precision pneumatic indicator. Illustrated are two indicators which form a control selector station accessory for remotely mounted controllers.

*Trade Mark of Fischer & Porter Co.

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FISCHER & PORTER CO.

1360 County Line Road, Hatboro, Penn.

SR-4 DEVICES IN INDUSTRY USES UNLIMITED

THE PROBLEM

How to weigh large castings conveniently and accurately.

THE BALDWIN SOLUTION

This 35 ton steel casting was easily weighed by placing three Baldwin SR-4 Load Cells under it.

Baldwin SR-4 devices enabled this large Eastern foundry to weigh faster and more accurately this huge semi-rotor, built for a Canadian hydro-electric plant. Three 50,000 pound SR-4 Type C Load Cells were used. Output of each of these cells ran to an SR-4 manual null-balance indicator. In this instance each cell was read separately and added together, while in other cases it might be preferable to use an SR-4 weighing system which electrically adds cell outputs.

Baldwin SR-4 devices have *uses unlimited* in industry . . . measuring load, pressure or torque economically, speedily and accurately. For the latest technical information please write to Dept. 3115, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

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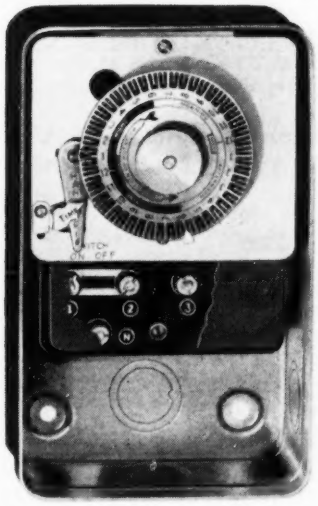
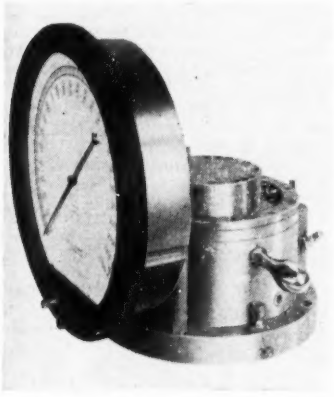


design of contact arms for more positive locking in "on" and "off" positions; etc.—*Paragon Electric Co., Two Rivers, Wis.*

For more information circle 223 on inquiry card.

Portable Force or Weight Indicating Assemblies

New self-contained portable hydraulic weighing units, accurate to 0.1 percent of scale, are available in 24



ranges from 0-500 lb. to 0-100,000 lb.; in four load cell sizes; with choice of 8½-in., 12-in., or 16-in. indicators. Immediate delivery; calibrated custom-made assemblies (to 10,000,000 lbs.) short delivery.—*A. H. Emery Co., New Canaan, Conn.*

For more information circle 224 on inquiry card.

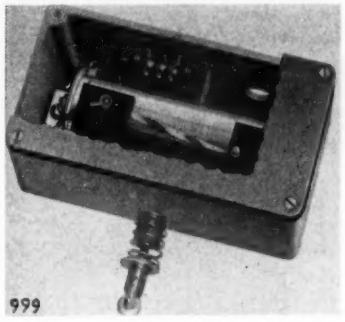
Displacement Pickup

New "Model 8620 Rectipot" linear-motion voltage dividing resistor is available in standard models operating in temperature range of −55 C. to +71 C. and a new high-temperature model for range of −55 C. to +149 C. Units can be had with either one or two electrically independent resistance units, both operated from the same shaft, for linear strokes of 0.5 in. to 5.25 in.; shaft free to rotate through 360 deg. Among features: output signal proportional to mechanical displacement; positive dust seal; simple front-end mounting; shaft extends out operating end only; no backlash between shaft and brush assembly; positive mechanical stops; linearities of 0.5 percent or better; life of over 1,000,000 cycles; zero resistance position with respect to stroke can be adjusted externally; non-linear outputs on special order.—*G. M. Giannini & Co., Inc., Pasadena 1, Calif.*

For more information circle 225 on inquiry card.

Displacement Pickup

New "Bulletin 68 Plunger Potentiometer" is a variable-resistance pickup for such control applications as constant-cutting-speed machine-



tool drives, winder drives, "dancer roll" systems, etc. When driven by a flat or rotary cam, pickup may interpret position as a linear or non-linear function, depending on shape of the cam. Operating plunger requires 0.5 in. linear movement for complete traverse of 10,000-ohm voltage-dividing resistor.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*

For more information circle 226 on inquiry card.

Pressure Pickup

New "Type 71-5 Baroresistor," for barometric range of 0-15 psia., is said to be unique in having variable-resistor winding and mechanism her-

metically sealed in a vacuum, thus providing zero reference pressure unaffected by temperature, also protecting against dust, fungus and humidity (meets MIL E5400). Accuracy, 2 percent; resistance, 7500 ohms. Most critical application: altitude adjustment of servo loop gain.—*Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.*

For more information circle 227 on inquiry card.

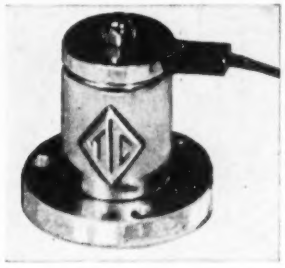
Miniature Pressure Pickups

New "Model 304 Gage Pressure Potentiometers" for remote measurement of hydraulic and pneumatic pressure in aircraft, guided missiles, etc., are miniature (1.62-in. diam.) units weighing 2 oz.; have a 0.5-watt electrical output which is linear with applied pressure. Bourdon tube deflection is transmitted to wiper contact on wire-wound resistance element by a ball-bearing linkage. Ranges from 0-100 psi. to 0-5,000 psi.; resolution of 0.4 percent; five standard resistance values from 1000 to 10,000 ohms. Units are not damaged by shock, vibration or nominal overpressure.—*Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.*

For more information circle 228 on inquiry card.

Vibration Pickup

New "Ultra-sensitive Inductive Vibrometer" weighs 11 oz., features magnetic circuit which provides suf-

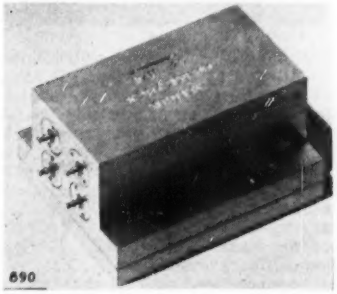


ficient output to drive recording galvanometers directly in many applications. Units can be supplied in natural frequencies from 15 to 80 cps. Units above 22 cps can be mounted in any direction. Amplitude range 0.06-in. total displacement. Output over 1 volt per inch per second for 600-ohm unit.—*Technical Instrument Co., Houston, Texas.*

For more information circle 229 on inquiry card.

Acceleration, Pressure and Strain Pickups

New line of inductive and floating-strain-wire pickups for linear and angular accelerations, etc., is announced. Among features: (1) Response only about intended axis of sensitivity; (2) Design characteristics permit measuring Coriolis acceleration force with no response to centripetal and centrifugal forces; (3) Erroneous responses introduced by components of angular rotation (Euler's Theorem) completely eliminated; (4) Each unit designed to meet user's specific requirements technically and physically; (5) Inductive type meets



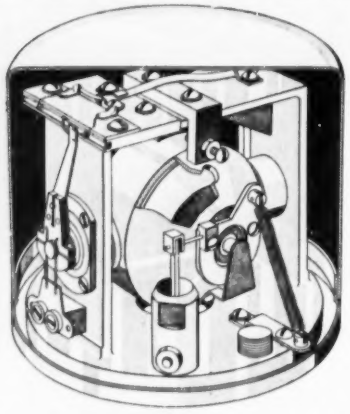
For more information circle 36 on inquiry card.

requirements which could not be met by strain wire type. Illustration shows "Model RA1-100" linear acceleration pickup with resolution of 0.06 percent or better, zero response to transverse acceleration, viscous damped to 0.6-0.7 of critical, temperature limits —65 F. to 200 F.—*Scientific Enterprises, 832 N. LaBrea, Los Angeles, Calif.*

For more information circle 230 on inquiry card.

Rate Gyro

New "Model 70" gyro, designed to register angular rates of rotation, provides electrical output signal for



telemetering and control; weighs 20 oz.; is suited for missiles and other air or ground applications; operates on 12 or 28 v.dc. 400 cps., or 110 v.ac. Coil spring or torsional rod restraints limit rotation of gimbal about its axis, depending on range desired. Units are manufactured with or without damping and hermetic sealing.—*Summers Gyroscope Co., 2328 Broadway, Santa Monica, Calif.*

For more information circle 231 on inquiry card.

Film-study Projector

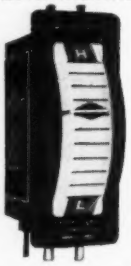
New "Kodascope Analyst Projector" is a 16mm. silent projector designed for athletic coaches and others who

wish to be able to reverse direction of films frequently and study in detail action shown on screen. A constant-speed motor drives blower; a two-speed governor-controlled motor drives film-moving mechanism. Among other new features is a "Daylight Projection Viewer" (carried in the projector case) which reflects image back onto a rear-view screen in front of operator.—*Cine Kodak Sales Div., Eastman Kodak Co., Rochester 4, N. Y.*

For more information circle 232 on inquiry card.

Remote Liquid-level Indicator

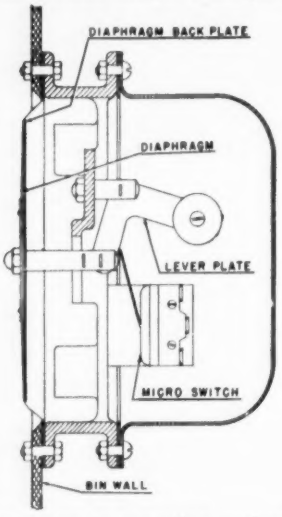
New "Wide Vision Remote Liquid Level Indicators" have a raised transparent face which permits indicator arm to be extended under the cover to a position where it can be viewed from the side as well as the front; are of the manometric type, with automatic temperature compensation.—*Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa.*



For more information circle 233 on inquiry card.

Bin-level Indicators

New improvements applying to all models of "Bin-Dicators" consist in modified frame design which permits

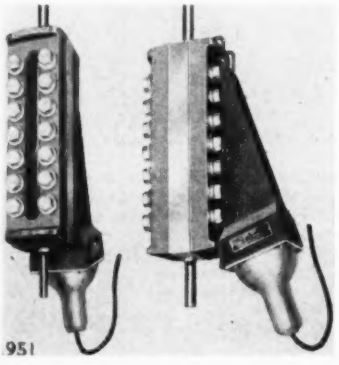


easier access to operating mechanism and wiring connections, better and simpler switch installation, and greater flexibility in wiring and conduit installations.—*The Bin-Dicator Co., 201-13946 Kercheval Ave., Detroit 15, Mich.*

For more information circle 234 on inquiry card.

Level-gage Illuminator

New "Yarway Type M" illuminator for flat glass water level gages uses a 100-watt sealed-in beam mercury vapor lamp, which produces about twice



amount of light for same power input as an incandescent lamp, and whose color is near peak of human-eye sensitivity curve: less affected by extraneous light.—*Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa.*

For more information circle 235 on inquiry card.

Signal Counters for Alarm Annunciator Systems

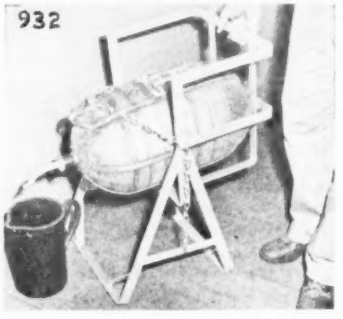
New "Model TC Tele-Counter" keeps continuous count of every off-normal signal indicated by "Tel-

Alarm" annunciator. Any number of individual alarm points of system may be selected for totalizing, or entire unit may be equipped. New "Model TCS," in addition to individual totalizers, has signal sequence selector, whereby initial off-normal signal at annunciator is immediately indicated by an illuminated window above corresponding counter totalizer: essential in determining which piece of equipment or step in process failed first, as in a series of pumps or continuous process functions. Both types can be adapted to any existing "Tel-Alarm" systems.—*Tigerman Engineering Co., 4332 N. Western Ave., Chicago 18, Ill.*

For more information circle 236 on inquiry card.

Container Tilter

New tilter handles 5- and 6½-gallon containers without spilling or splash-

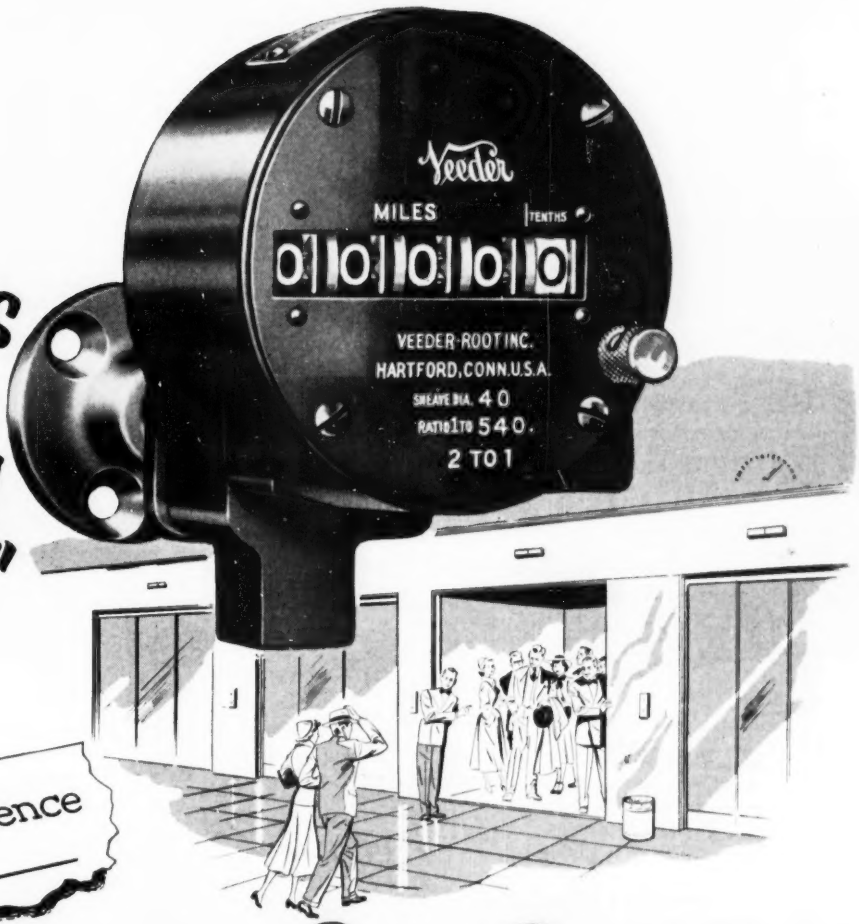


ing. A chain holds container in position when tilted.—*General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32, Pa.*

For more information circle 237 on inquiry card.

Infrared-radiation Type Intrusion Alarm

New "Photoelectric Intrusion Alarm Set PIA" consists of "Type L60B" light source which projects a beam of



It counts your "UPS and DOWNS"

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

Elevator Mileage Recorders give accurate figures on vertical miles . . . so that it can be plainly seen...*in advance*...when it's time to replace cables, overhaul cars, motors, and what have *you . . . including your life.*

Yes, the V-R wheelmark monogram protects millions of people daily, from the depths of the sea to the stratosphere. Of course, not all V-R Products and services are available nowadays . . . but if your work counts importantly in defense, then you can count on Veeder-Root to help you, as soon as rush commitments permit.

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONN.

Chicago 6, Ill. • New York 19 • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland

Offices and agents in principal cities

"Counts Everything on Earth"

For more information circle 37 on inquiry card.

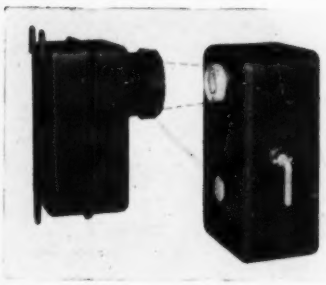
Linear accelerometers are manufactured by Statham Laboratories for measurement in ranges from ±0.5g to ±1,000g. Unbonded strain gage accelerometers have higher natural frequency than is usually attainable with other types of pickoffs. For maximum possible output, the mechanical construction of these instruments is such that movement of the suspended mass produces a change of resistance of all four arms of the complete balanced bridge. The resistive nature of the bridge permits the use of these accelerometers in either A.C. or D.C. circuits.

Please request Bulletin No. 4.0.

Statham
LABORATORIES
• Los Angeles 64, Calif.

For more information circle 38 on inquiry card.

NEW INSTRUMENTS

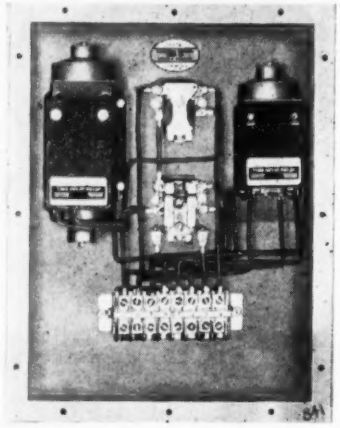


infrared (invisible) radiation, and "Type A20C Photoelectric Control." Maximum distance for operation is 50 ft.—*Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.*

For more information circle 238 on inquiry card.

Automatic Engine-cranking Control Systems

New "Pantro" panels control cranking cycle of diesel and gasoline engines by allowing engine to crank and

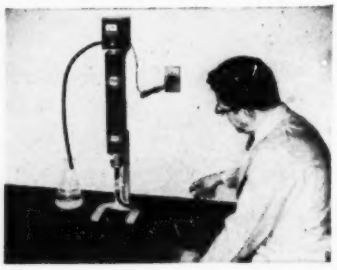


also to rest for predetermined intervals. Number of cycles and durations are adjustable. Sequence stops when engine starts. Manual control can take over at will of operator.—*Industrial Control Panel Co., 247 E. Illinois St., Chicago 11, Ill.*

For more information circle 239 on inquiry card.

Water Demineralizer

New "1953 Model Permanent Cartridge Demineralizer" employs same mono-column ion exchange technique reported effective in experimental decontamination of water containing radioactive products; has 10 gph. capacity; features new laboratory stand

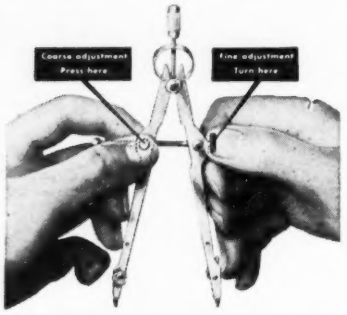


for convenient mounting; electric purity indicator, and flow-rate indicator for adjusting intake flow to optimum rate for most efficient ion exchange action.—*Penfield Mfg. Co., 19 High School Ave., Meriden, Conn.*

For more information circle 240 on inquiry card.

Bow Compass

New "Speed-Bow" draws circles from $\frac{1}{8}$ in. to 10 in. in diameter, coarse settings made quickly by a finger-pressure release and fine adjustments

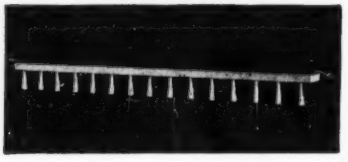


by a thumbscrew. It is equipped for use with pencil and four types of pen attachments; with addition of two needle points it becomes a divider capable of scribing on steel.—*V. & E. Mfg. Co., P. O. Box 950 M, Pasadena 20, Calif.*

For more information circle 241 on inquiry card.

Electrostatic Neutralizer

New "Magic Wand" electrostatic neutralizer, said to improve processes and eliminate electrostatic fire and



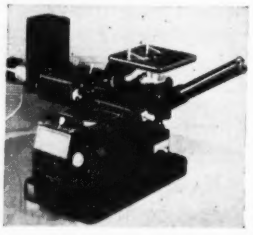
explosion hazards, requires no external source of power, has no sharp points to damage stock or injure operators.—*Herman H. Sticht Co., Inc., 27 Park Pl., New York City.*

For more information circle 242 on inquiry card.

MICROSCOPES

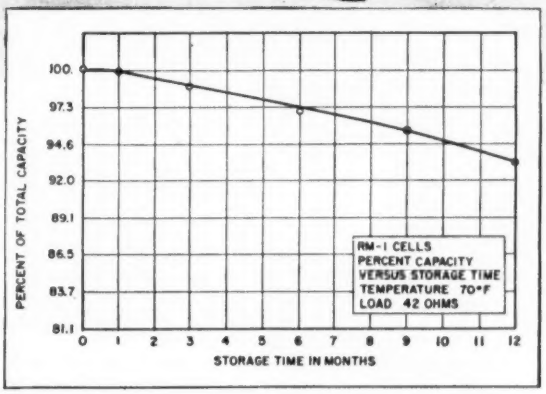
Microscope-Metallograph

New "CSF" metallurgical microscope and metallograph (made in Italy by Officine Galileo) is said to



occupy one-tenth to one-twentieth of space normally taken by instruments used for this type of work. Group observation is made possible by pro-

For Long Shelf Life... Use Mallory Mercury Batteries



For battery-powered instruments that operate intermittently . . . or for applications involving long periods of idleness, the long shelf life of Mallory Mercury Batteries is an important characteristic.

Mallory Batteries do not deteriorate or lose an appreciable amount of power during long storage periods, even under the most adverse conditions of humidity and temperature extremes. The curve shown is typical of the performance you can expect when Mercury Batteries are used for instrument power supply.

For continuous or intermittent operation at microampere drains or loads of 50 amperes, Mallory Mercury Batteries have many important advantages that will help you design lighter, more compact equipment . . . equipment that will give more hours of service life.

Let us send you a copy of our new Technical Bulletin 1-6. It contains complete information on single cells and multi-cell stacks and packs.

Here are other advantages that may suggest ways you can use Mallory Mercury Batteries to advantage

- High ratio of energy to volume and weight
- Leak-proof, dimensionally stable construction
- Uniform discharge characteristics
- No need for recuperation periods
- Operation over wide temperature and pressure ranges
- Resistance to humidity and corrosive conditions
- Highly resistant to impact and acceleration

For Transistor Applications

The constant voltage-constant current characteristics of Mallory Mercury Batteries make them exceptionally well suited to transistor applications.

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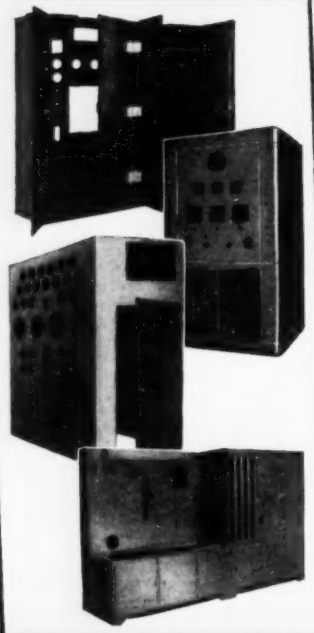
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. INC., INDIANAPOLIS 6, INDIANA

For more information circle 24 on inquiry card.

FOR ACCURATE FABRICATION of CUBICLES, CABINETS, PANEL BOARDS, see LITTLEFORD



Manufacturers of Electrical and Hydraulic Control equipment must have accuracy in the fabrication of Cubicles, Cabinets, Control Boards and Panel Boards. Accuracy comes through experience in knowing how to shear, bend, form and weld plate and sheet metals. Littleford has that experience, plus skilled craftsmen, as industry has been served by Littleford since 1882.

These long years of producing fabricated products reflect in the finished unit. Littleford facilities are modern and afford an unprecedented standard of dependability and quality. If you have a problem involving accurate fabrication remember there is no substitute for experience, and no substitute for Littleford workmanship.

Send blueprints and be assured of quality at low cost.

FABRICATORS OF PLATE AND SHEET METAL PRODUCTS FOR INDUSTRY SINCE 1882

LITTLEFORD

LITTLEFORD BROS., INC.
404 E. Pearl St.
Cincinnati 2, Ohio

For more information circle 40 on inquiry card.

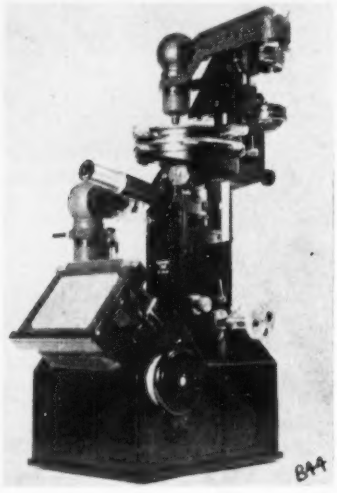
NEW INSTRUMENTS

jecting light beam through camera housing onto a screen. Owing to inverted design, all operations are confined to a volume of 13x8x8 in. An inclined eyepiece tube makes observation from seated position comfortable and a slight pull on mobile prism knob directs light path to camera screen at left.—*Opplem Co., 352 Fourth Ave., New York 10, N.Y.*

For more information circle 243 on inquiry card.

Universal Microscope

New improvements in Reichert (Austrian) "MEF" camera microscope are: (1) transmitted light



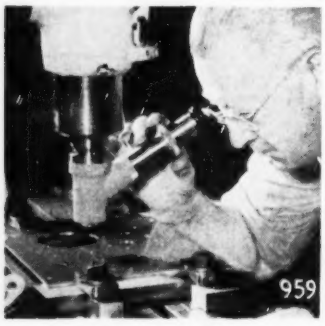
source mounted on a rotating carrier, (2) incident light source can be swung to back, (3) calibrated drum for camera bellows extension, (4) new base gives more pleasant appearance.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

For more information circle 244 on inquiry card.

FOR INSTRUMENT SHOP

Machine-tool Locating Microscope

"Model 11 Machine Tool Locating Microscope" provides 30x magnification; is designed to be mounted directly in machine spindle or on an offset bracket; can be adapted to nearly any machine tool. A roof prism erects image so that all table movements made by operator appear in true direction. Field of view takes in

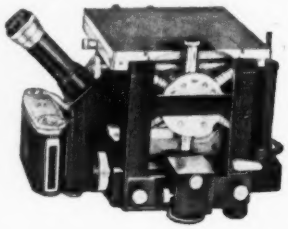


0.25-in. of workpiece. New instrument will not destroy template during machining.—*Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle 245 on inquiry card.

Interference Microscope

New "Zeiss Opton Interference Microscope" measures surface-finishes and roughness-depths from 0.80 to

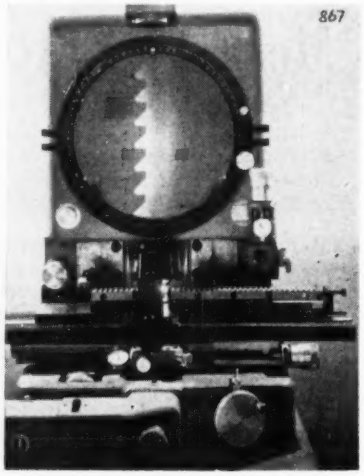


1.2 micron; permits visual as well as photographic checks to be made. A 35mm film still camera produces standard 1 x 1.5-in. negatives. Magnifications are 80x, 200x and 480x. Built-in illuminations for white light and thallium light.—*Carl Zeiss, Inc., 485 Fifth Avenue, New York 17, N. Y.*

For more information circle 246 on inquiry card.

Fixture for Optical Gaging of Broaches

New "Broach Locating Fixture" makes possible checking of all teeth of broaches for tooth form, spacing,



and wear for entire length of a broach. It utilizes optical system of "Model IIA" Kodak Contour Projector. Indexing head of fixture is fixed to base member and carries two special metal mirrors which can be moved as a unit in and out between teeth of broach to positive stops at each end of its travel. Positioning mirror assembly against forward stop places mirrors on either side of a row of teeth for tooth-to-tooth inspection. Inadvertent forward thrust of mirrors against broach is prevented. An adapter supplied with fixture is inserted behind standard 45 deg. mirror attachment of Kodak Contour Projector.—*Optical Gaging Products, Inc., 26 Forbes St., Rochester 11, N. Y.*

For more information circle 247 on inquiry card.

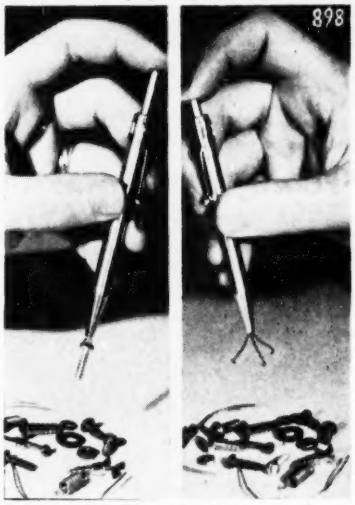
Engraving-machine Slide

New sectional copy-holding slide saves time in engraving letters and numerals at right angles; saves space on job by allowing engraving of more characters per line; may be used on any model "Engravograph" with standard ⅝-in. or 1¼-in. blanks.—*New Hermes Engraving Machine Corp., 13-19 University Place, New York 3, N. Y.*

For more information circle **248** on inquiry card.

Automatic-pickup Tweezer

New "Automatic Pick-up Tweezer" has three hooked steel fingers, operated from top plunger, to grasp and

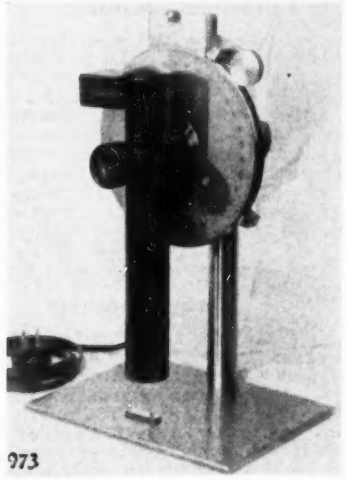


release odd-shaped, hot, sterile or highly-polished objects. Made of stainless steel, it can be steam-sterilized or boiled.—*Dept. 19-D, Win Sales Co., P. O. Box 257, Forest Hills, N. Y.*

For more information circle **249** on inquiry card.

Goniometer-collimator

New "Angle Setting and Checking Collimator" is said to make this versatile type of device available to shops and inspection departments where budget restrictions, accuracy standards or other reasons would not permit consideration of maker's more expensive and ultra-precise "G-12"



An Edison Thermostat maintains critical temperature of lead dioxide in micro-combustion train.

Making Chemicals React Better through

Precision Temperature Control

This Fisher Scientific Micro-Thermostatic Sleeve and Micro-Combustion Furnace is used in the gasometric analysis of nitrogen-containing compounds for the determination of carbon and hydrogen.

The gasses in the combustion tube are passed over granulated lead dioxide in the thermostatic sleeve to assure the removal of nitric oxides, thus preventing their absorption by the CO_2. Lead dioxide absorbs the oxides of nitrogen more rapidly at 180°C, but above this temperature oxygen begins to be liberated. An Edison thermostat was selected for this application because an accurate and constant temperature control must be maintained to assure the complete removal of all nitrogen oxides. Optimum temperature conditions are assured by the thermostat's sealed-in-glass construction and tamper-proof design. A neutral arc-quenching atmosphere preserves the contacts from wear, dust, corrosion or handling.

The exact duplication of results from assay to assay is made possible by the permanence of the thermostat's control setting. This remains constant over years of service during which the contacts may operate thousands of times or, as in many protective devices, not at all.

Because Edison Thermostats are engineered for each application to meet your particular operating requirements, you are assured that the optimum life, stability and tolerance has been built into your thermostat.

Thomas A Edison
INCORPORATED
Instrument Division
24 Lakeside Avenue, West Orange, New Jersey

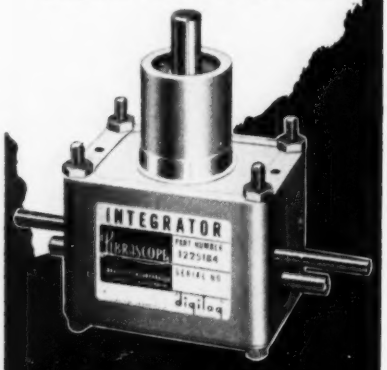
EDISON INSTRUMENTS

YOU CAN ALWAYS RELY ON EDISON

For more information circle **41** on inquiry card.

Ball-Disc Integrator

A small size precision integrating mechanism, the Ball-Disc Integrator. Used for totalizing, rate determination, differential analyzing, closed loop mechanical servo-element, and may be applied as a precision variable speed drive or other applications. High performance and long life are assured by the use of super-finished balls and tungsten carbide disc. Size: Width 1¾", Length 2¾", Height 3¾", Wt. 21 oz.



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For more information circle 42 on inquiry card.

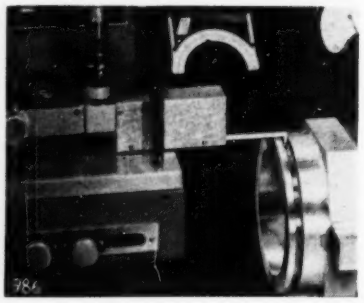
NEW INSTRUMENTS

instrument. It sets (or checks) angles to 30 seconds of arc; can be used for measurement of any external angle, tapers, hidden surfaces such as valve seats, parallelism and right angles; also for checking straightness of surface plates, machine beds, etc.; or to set or check cutting angles on lathes, milling machines, etc.—*Mitchell Scientific 39 MacQuesten Parkway North, Mount Vernon, N. Y.*

For more information circle 250 on inquiry card.

Surface-roughness Tracer

New "Profilometer Type KB Tracer," for measuring surface roughness across bottom of flat-bottomed

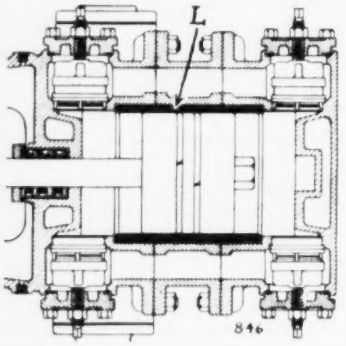


grooves to 0.25-in. depth and behind shoulders to 0.25-in. height, can also be used in ID's from 25/64 in. to flat, and on all OD's and flats, where part can be mounted on a "Linear Pilotor" with work surface horizontal.—*Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.*

For more information circle 251 on inquiry card.

Instrument Air Compressors

New "Class ATL and ATCL Oilfreair and Oilfregas" compressors feature steel-backed carbon cylinder liner (L), carbon piston-rod packing, oil

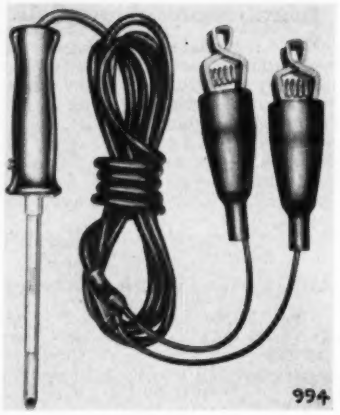


baffle on piston-rod, segmented cylinder, accessible cooling passages, and other refinements; are guaranteed to compress air or gas entirely free of oily vapor.—*Pennsylvanic Pump & Compressor Co., Easton, Penna.*

For more information circle 252 on inquiry card.

Battery Soldering Iron

New soldering iron can be connected to either 6 or 12 volts; is for use on any battery regardless of voltage; melts solder in 20 seconds; was originally developed as standard battery iron for Armed Forces; will do three times heavier work than size



indicates because element is embedded in tip small enough for finest soldering.—*Hexacon Electric Co., 175 W. Clay Ave., Roselle Park, N.J.*

For more information circle 253 on inquiry card.

FOR INSPECTION AND TESTING DEPARTMENT

Inspection Light

New "Model 225 Tube-a-Lite" for inspection of cavities, etc., is a portable 25-in. 15-watt fluorescent lamp

with plug-in ballast and standard starter.—*Mfg. Div., Larrimore Sales Co., P. O. Box 1234, St. Louis 1, Mo.*

For more information circle 254 on inquiry card.

Cold-test Chamber

New "Sub-Zero Test Chamber" is available in sizes from 1.5 to 4 cubic feet; temperature range from −10 to −120 F. Where required, lid can be equipped with a frost-proof observation window and interior illumination installed. Option: either indicating or recording thermometers. Temperature control knob located inside instrument cabinet to prevent unauthorized tampering.—*Sub-Zero Products Co., Cincinnati 29, Ohio.*

For more information circle 255 on inquiry card.

Explosion Chamber

New explosion chamber, designed to fill testing needs of manufacturers of airborne electrical or electronic equipment, incorporates new safety features such as automatic fuel metering tank constructed in accordance with ASTM standards. Advanced operating facilities include an ignition cir-

For *Critical* Applications

Triplett 630-A Has No Counterpart

Accuracy
to 1½%

Readability
with a Mirror-Scale

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with ½% resistors

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For more information circle 43 on inquiry card.

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Brush holders, commutators,
electronic specialties
Standard sizes or to your specification
4-6 Micro finish
Minimum coefficient of friction,
wear, brush noise
Diameters from .035 — to
your specification
Operating capacities — 1 amp intermittent,
.6 amp continuous load
Rhodium or gold plating over silver rings
No porosity factor
Concentricity guaranteed to .002 T.I.R.
— to your specification

specify

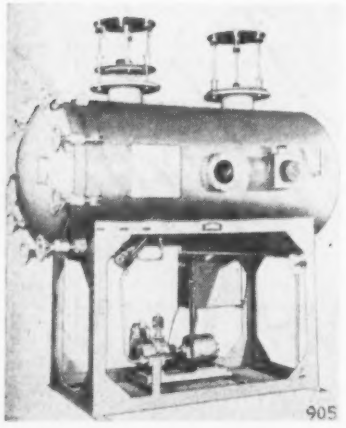
ICI

Our staff available
for consultation on your problem.
Write for
ICI catalog
containing
complete
engineering
data on
standard sizes.

Instrument Components Inc.

1834 Franklin St., Santa Monica, Calif.
Division: Marshall Engineering Company

For more information circle **44** on inquiry card.

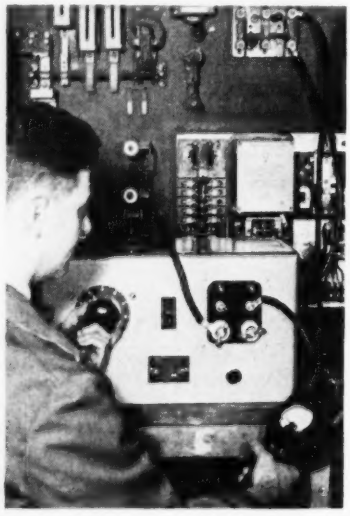


cuit whereby firing of gaseous atmosphere is possible at any altitude up to 70,000 feet; viewing windows; any desired arrangement of electrical connections; access for high-speed shafts and tuning shafts if desired.—*Bowser Technical Refrigeration, Terryville, Conn.*

For more information circle **256** on inquiry card.

On-the-spot Tester for Current-actuated Devices

New "Model 1010 Industrial Multi-Amp" is said to be the first portable high-current test unit making it possible to check circuit breakers, over-

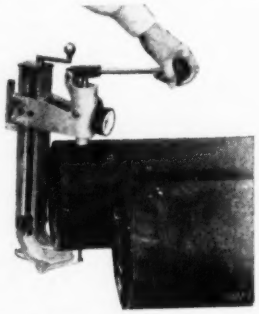


load relays and other current-actuated devices before they are installed, when they are installed, and periodically after they are in service. It is adjustable in stepless increments with fingertip control; draws negligible power from line in addition to that required to actuate device being tested; is equally suited to checking devices with high impedance and low current requirements as it is for testing devices with low impedance and high current requirements. Input: 0-10 amp. 110 v.ac.; output; 0 to 500 amps. in 5 ranges; weight, 60 lbs.—*Multi-Amp. Corp., Harrison, N. J.*

For more information circle **257** on inquiry card.

Portable Hardness Tester

New "Porta-Brinell" has 12-in. gap and 4.5-in. throat. Penetrator makes an impression at a controlled hydrau-



lic force of 500 kg.; impression is read with a standard Brinell microscope. Range, 20 to 500 Brinell. Tester weighs 17 lbs., works in any position. —*Blosjo Enterprises, 5310 Golden Valley Rd., Minneapolis 22, Minn.*

For more information circle **258** on inquiry card.

Inspection Magnifier

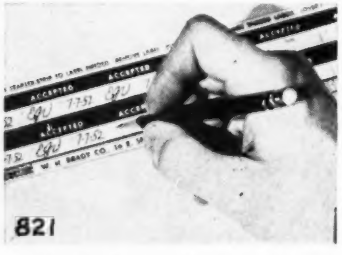
New "Model 220B" six-power magnifier has two 2-in. plano-convex lenses affording sharp focus and un-

distorted field of views.—*Mfg. Div., Larrimore Sales Co., P.O. Box* 1234, *St. Louis* 1, *Mo.*

For more information circle **259** on inquiry card.

Adhesive Write-on Labels

New "Self-Sticking Write-On Labels" combine a printed form and write-on space. Printed part: "ACCEPTED," "REJECTED," etc., with differ-



ent color background for each wording. Write-on space is for authorizing person to write in necessary data with pen, pencil, ballpoint, rubber samp or typewriter.—*Dep't* 248, *W. H. Brady Co.*, 727 *W. Glendale Ave., Milwaukee* 12, *Wis.*

For more information circle **260** on inquiry card.

Torque-testing Fixture

New torque-testing fixture features adjustable spindle, set in instrument bearings and held in rigid alignment to permit rapid engagement of driver

with work; accommodates a wide selection of torque wrenches. Illustrated is a typical application: testing ultimate strength of a screw. Two models: capacities of 0 to 200 inch-pounds and 0 to 150 foot-pounds.—*P. A. Sturtevant Co., Addison, Illinois.*

For more information circle 251 on inquiry card.

Balancing Machines

New "Micro-Poise" static balancing machines for production lines use optical magnification for precisely measuring and locating unbalance in

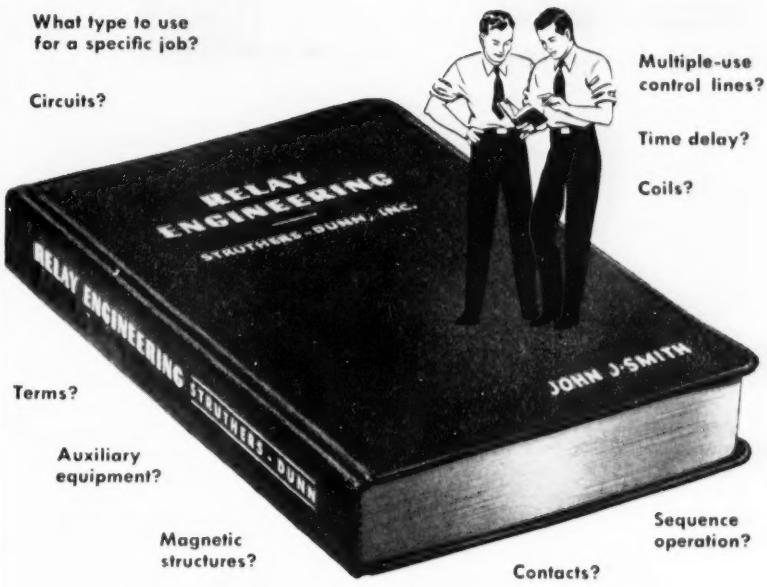
a few seconds after releasing operating handle. Among features: other operations than balancing can be performed. Fifteen standard models. Photo shows application on jet-engine disk-and-blade assemblies.—*Micro-Poise Engineering & Sales Co.*, 14851 *Grand River Ave., Detroit 27, Mich.*

For more information circle 262 on inquiry card.

Tensile Testing Machine

New "Model 49RC Electro-Hydraulic Tensile Tester," for routine production and quality control as well as for research laboratory, has a rigid crosshead and uses strain gages for load measurements. Hydraulic drive system provides constant rates of elongation infinitely adjustable on a throttle dial; no gear change, no overshoot at high speeds. Full-scale load ranges from 5 grams to 5000 lbs. ("Model 51RC to 10,000 lbs.). Standard rates of extension from 0.1 to 20 in. per

What's your relay or timer question?



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Here is relay-timer experience! Over 18,000 copies are now in use helping engineers, designers and others solve relay-timer problems. Replete with more than 1100 diagrams, illustrations and data tables, this pocket-size book is the ideal reference manual for everyone concerned with relay or timer selection, application or service.

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For more information circle 45 on inquiry card.

"SERV-RITE"

Insulated Thermocouple Wire Extension Lead Wire

FOR

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CHROMEL ALUMEL
IRON CONSTANTAN
COPPER CONSTANTAN
IRON CUPRONEL

No matter what your wire or insulation requirements may be, you can depend on Gordon "Serv-Rite" insulated wire for pyrometers—recognized as a standard of highest quality for nearly half a century. All "Serv-Rite" wire is now manufactured in the new, completely modern Gordon plant, employing up-to-date equipment and machinery, supervised and operated by skilled technicians—your guarantee of continued precision quality. In addition to maintaining large stocks of all common types of wire, Gordon will manufacture special insulation, in long or short runs, to suit your individual needs and meet your most rigid specifications.

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Nylon Braid
Stainless Steel Armored Braid
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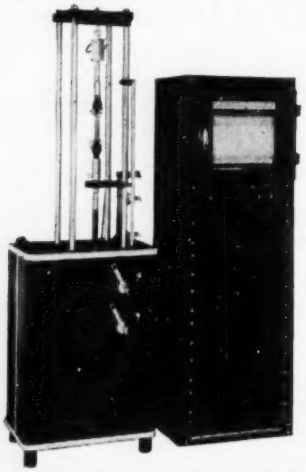
For more information circle 46 on inquiry card.

NEW INSTRUMENTS



minute; special from 0.2 to 20 ipm. Automatic cycling available. Unique feature is that return stroke speed can be adjusted independently of pulling speed.—*Thwing-Albert Instrument Co., Penn St. at Pulaski Ave., Philadelphia 44, Pa.*

For more information circle 263 on inquiry card.

Ground-resistance Tester

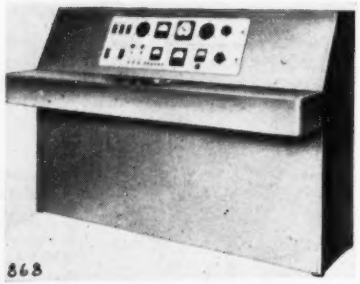
New "Type W4 Groundometer" is a null-reading Wheatstone bridge with full-scale ranges of 1-5-10-50-100-500-

1000-5000 and 10,000 ohms. Self-powered by six flashlight cells, instrument has, in carrying case, a compartment for all necessary reference rods and test leads for proper spacings. Only the 10-in. reference rods need be used: Y-reference electrode may be as high as 400 times resistance of ground being measured.—*Borden Engineering Co., New Providence, N. J.*

For more information circle 264 on inquiry card.

Instrument, Meter & Relay Test and Calibration Console

New "Tesco Meter Testing Power Supply" provides a stable and controlled source of single-phase potential and single-phase current for general testing purposes, with means for adjusting phase angle so that power may be supplied at any desired power fac-

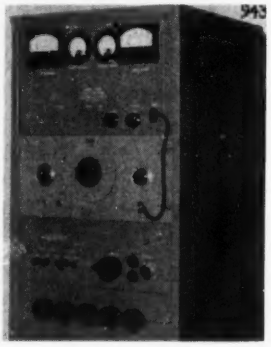


tor, leading or lagging. Among uses: (1) instrument standardization; (2) gang test of thermal demand meters; (3) gang test of watthour meters, with or without demand attachments; (4) testing network and other types of relays.—*Eastern Specialty Co., Philadelphia 40, Pa.*

For more information circle 265 on inquiry card.

Variable-frequency Supply

New "Model 200A Power Amplifier" is a source of variable-frequency a-c. for component and equipment testing at specified frequencies. It is rated



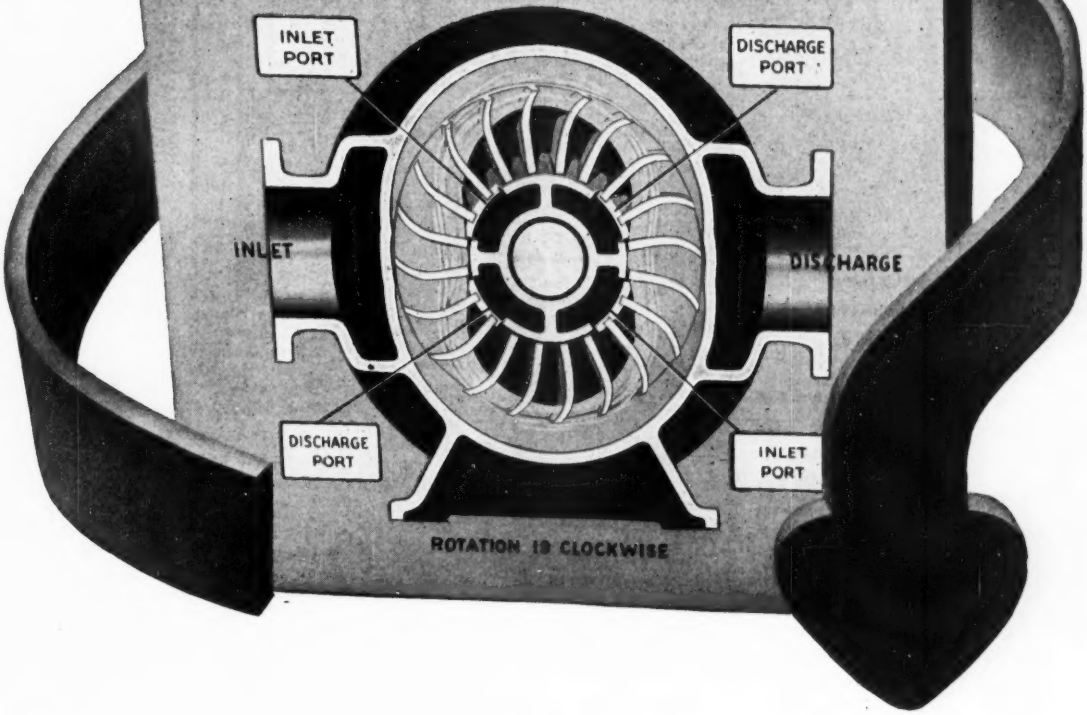
1000 watts at 75 to 100 percent power factor; distortion not more than 1.5 percent at 100 percent pf and not more than 3 percent at 75 percent pf; frequency range 40 to 4000 cps. Output voltage adjustable from 0 to 115 volts.—*John Fluke Engineering Co., 1111 Nickerson St., Seattle 99, Wash.*

For more information circle 266 on inquiry card.

Stethoscope for Mechanical Trouble-shooting

New "Serviceman Soundscope," for acoustically locating and diagnosing mechanical troubles, comprises an earpiece containing a sound-box system and transmitter, with a diaphragm

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

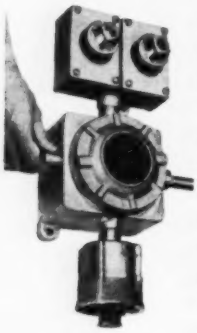
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

DETECT combustible GAS

INDICATE • RECORD • CONTROL

J-W Model F Indicator checks the presence of combustible gas at inaccessible locations. Aspirator bulb draws air mixture through sampling hose and probe. Meter registers combustibility instantly. Fully portable, dry-cell operated.

MODEL F



MODEL EE

J-W Models E and EE Alarms monitor fixed installations where explosive hazards may exist. For continuous operation from standard 115-v a-c line. Actuate audible or visual signals, control valves or motors. Model EE is explosion proof. Model E is for installation remote from sensing unit.

J-W Sentinel Alarm serves as a fire-danger watch-dog under conditions of special localized combustible-gas hazard—such as: welding, electrical work, tank cleaning, etc. Storage-battery operated, inbuilt charger, penetrating audible alarm.

SENTINEL

Other models available for laboratory, oil-well logging, and other specialized uses. Your inquiry is invited on designs to meet particular requirements.

Standard for over 25 years

Write for complete information

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For more information circle 47 on inquiry card.

said to be capable of "picking up sounds which cannot be heard by the human ear and amplifying them until they are clearly audible."—*Jas. P. Marsh Corp., Skokie, Ill.*

For more information circle 267 on inquiry card.

Flash-point Testers

New testers for determining flash points of fuel oils, gas oils and soybean oils, comprise a transformer-

controlled "Speedi-Heet" duplex heater assembled with A.S.T.M. Pensky Martens shield, cap and cover in one unit; meet A.S.T.M. D 93 requirements. Supplied also in gas- and rheostat-controlled models.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle 268 on inquiry card.

FOR THE LABORATORY

Hand Refractometer

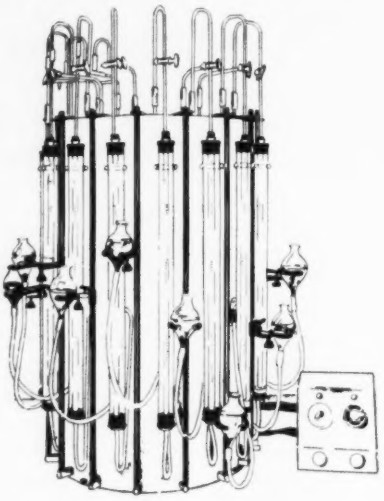
New "OPL" (French-made) refractometer for food, textile and chemical industries utilizes refraction method

of determining dry solids contents. Two models: (1) 0 to 50 percent dry solids by 0.5 percent and 0-30 ⅓° for growers; (2) 40 to 80 percent by 1 percent (accuracy 0.5 percent) for processors. Equipped with thermometer on test prism.—*E. J. Van der Leur, 60 Beaver St., New York 4, N. Y.*

For more information circle 269 on inquiry card.

Oxidation Apparatus

New "Model A GBF-JRS Oxidation Unit" is for determining amount of oxygen absorbed by rubber, plastics,

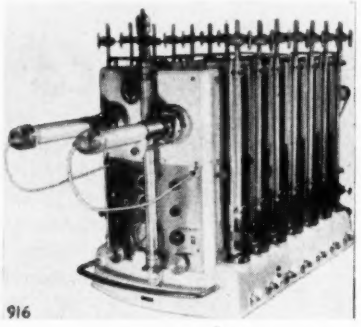


fibers, etc., which deteriorate on exposure to air or oxygen; has various other uses.—*G. F. Bush Associates, Box 175, Princeton, N. J.*

For more information circle 270 on inquiry card.

Warburg Apparatus

New models of Warburg Manometer Apparatus are said to provide accuracy and reproducibility of experimental conditions heretofore unobtainable. Rectangular "Models US and USL" provide for temperature constancy of 0.005 C.; circular "Models UV and UVL," 0.01 C. "Models USL and UVL" are equipped for photosynthetic quantum reactions with lights focusable on each individual

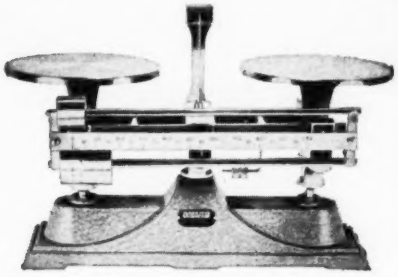


reaction vessel. Exchangeable lights for several spectral ranges are available. New double-capillary manometer, combining two capillaries 2 mm. apart in a single rod, permits easier and more accurate reading over a single scale without interrupting shaking. "Duplex" type is said to provide for pressure recording ten times as sensitive and accurate as is obtainable with conventional U-shaped Warburg manometers. New magnetic tilting reaction vessel allows several components to be put into reaction by manipulating magnets.—*Bronwill Scientific, Inc., 40 Worth St., New York 13, N. Y.*

For more information circle 271 on inquiry card.

Precision Balance

New type of balance has a micrometer poise which enables balance to be used for a range from 0.5 to 1000 grams without additional weights, may be slid along beam for rapid

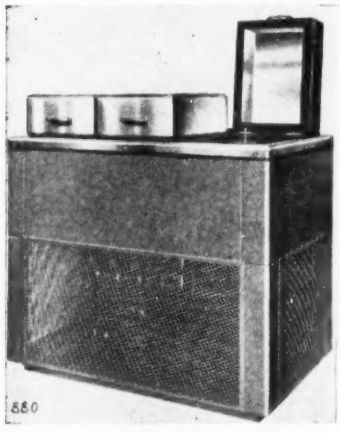


traverse and rotated for final positioning. Poise barrel is calibrated in 0.5-gram increments which subdivide 10-gram beam divisions. Balance illustrated, equipped with 7-in. stainless steel plates and etched aluminum graduated beam, has 5000-gram capacity, 0.5-gram sensitivity, undivided tare beam of 1-lb. capacity.—*Ohaus Scale Corp., 1050 Commerce Ave., Union, N. J.*

For more information circle **272** on inquiry card.

Cloud-and-pour-test Cabinets

New cabinets for standard cloud and pour tests produce trouble-free refrigeration for temperatures as low



as −90 F. 3-compartment cabinet operates at 30 F., 0 F., and −30 F.; 2-compartment cabinet operates at −60 F. and −90 F. Compartment thermostats hold temperatures within 2 F.; coldest compartment reaches −90 F. in about 2½ hours. Safety interlocks prevent compressor damage when starting warm.—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

For more information circle **273** on inquiry card.

Stainless Steel Filters

New "Grade X" porous stainless steel filter sheet is said to differ from previously available materials by an approximately doubled tensile strength, by extremely smooth surface, and by close control of thickness. New material is available in the form of finished line filters. Tensile strength is about 25,000 psi. Sheet material is

For more information circle **48** on inquiry card.

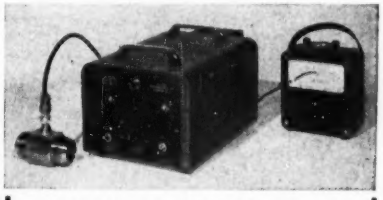
☆ *NEW* POTTER FLOWMETERS for ACCURATE TEST DATA

New Frequency Converter Models Have High Performance Characteristics

Now, improved models of the Potter Electronic Frequency Converter make it possible to utilize more fully the accuracy and sensitivity of the unique Potter Flow Sensing Element.

Greater stability over a wider temperature range, freedom from drift due to line voltage changes, faster response speed and longer life have been built into all the new units.

New models of the laboratory-type converter incorporate such features as adjustability for density changes from Specific Gravity .6 to 1.6, multiple-input models for measuring the output of one of a number of sensing elements, dual output jacks, integral 100 cps frequency standard, switch for dividing frequency of input signal by 0.5, 1, 2, 4, 8 and 16.



LABORATORY FLOWMETER SYSTEM consisting of Flow Sensing Element, Model 12-(1) Electronic Converter adjustable for density from Sp. Gr. .6 to 1.600 and indicating milliammeter. High-speed recorder, electronic potentiometer or other type of instrument can be substituted for milliammeter.

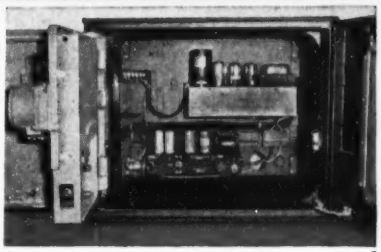
SPECIFICATIONS

Input signal range: 5 to 3200 cps.
Input sensitivity: .005 to 5.0 volts rms.
Drift: Blower-cooled to eliminate thermal drift. Less than .25% drift for 5 volt power drift.
Calibration frequency: Integral 100 cps (± .15 cycles) tuning fork standard.
Linearity: Within .1% at all points within operating range.
Adjustability: Full-scale deflection for frequencies from 50 to 3200 cps.
Specific Gravity Adjustment: Ten-turn Helipot, from .600 to 1.600.
Multiple-Input: Available with 1 to 5 input channels.
Totalizer: Single-channel unit available with integral six-digit counter.
Instruments: Can be used to operate electronic potentiometer, high-speed recorder, or any 0-1 ma dc instrument.

New Potter Electronic Totalizer counts total number of output pulses produced by Flow Sensing Element. Instrument has six-digit counter plus two banks of decade read-out lamps; counts up to 99,999,999 pulses. Equipped with resets for counter and read-outs, and start-stop switch to facilitate counting over timed interval.

TACHOMETERS

Any of the Potter Frequency Converters can be used as a tachometer to measure frequency of pulses produced by a rotating magnet. Systems for both laboratory and industrial applications are inherently explosion-proof at sensing element location, accurate, easily installed, and adjustable to read or record directly in rpm.



INDUSTRIAL MODEL of the Potter Electronic Frequency Converter is mounted directly inside the case of Electronic Potentiometer. Instrument can be recorder, indicator or controller.

SPECIFICATIONS

Input signal range: 10 to 600 cps.
Input sensitivity: 5 mv to 200 volts.
Drift: Thermal drift less than .1% from 40 to 150° F. ambient.
Negligible drift from 75 to 135 volts.
Calibration frequency: 60 and 120 cycles from line current.
Adjustability: Full-scale deflection for input from 80 to 600 cps.
Specific Gravity Adjustment: Available from 0.700 to 1.000
Multiple-input: Available with 1 to 8 input channels.
Instruments: Can be used with any industrial model Electronic potentiometer: Precision Indicator, Circular Chart Recorder, Strip Chart Recorder.

The NEW Industrial Model single-range Potter Electronic Frequency Converter mounts directly inside an electronic indicating or recording potentiometer, uses line frequency as a standard for calibration.

Because both the signal voltage and the bridge energizing voltage are supplied from the same source, the effects of line voltage variations are completely eliminated.

The industrial model converter, installed in an *ElectroniK* Precision Indicator and used with Potter Flow Sensing Elements, has been thoroughly tested at many of the foremost air research centers. System accuracy, according to users reports is within ½%.

Systems accuracies within ± .1% have been obtained during tests of several weeks duration.

Send for further information.

POTTER
AERONAUTICAL CO.
87 Academy Street, Newark 2, N. J.

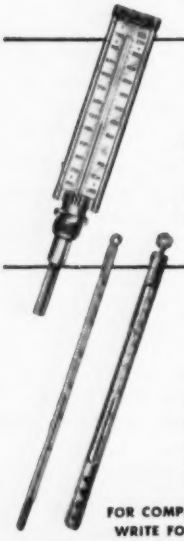
PALMER
MERCURY ACTUATED
Temperature Indicating Instruments

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.



INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG 200 G

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THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1500

For more information circle 49 on inquiry card.

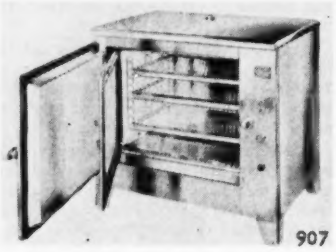
NEW INSTRUMENTS

available from stock in 0.040 in. thickness, with 10-micron mean pore opening. Other thicknesses, from 0.020 in. to 0.125 in., available from stock or supplied on short notice.—*Micro Metallic Corp., 35 Sea Cliff Ave., Glen Cove, N. Y.*

For more information circle 274 on inquiry card.

Bacteriological Incubators

New heavy-duty improved type laboratory incubators are of gravity convection wet-type having an automatically controlled temperature range from

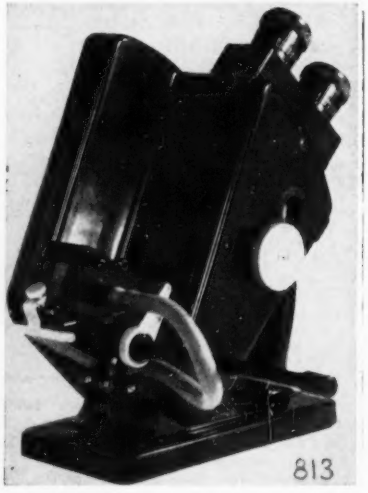


room temperature to 60 C. with not more than 0.5 C. variation after working temperature is reached. Two models are offered: single-door (illustrated). 25x19x19-in. inside dimensions; and double-door, 37x19x25-in. inside dimensions.—*The Fischman Co., 10th St., Philadelphia 33, Pa.*

For more information circle 275 on inquiry card.

Variable-temperature Refractometer

New "OPL" (French-made) "Universal Refractometer" for measuring refractive index of liquids or solids, transparent or opaque, measures in-



dex of liquids by refraction; of solids by reflection; also gives close approximation of dispersion factor. Design assures fatigue-free operation. Water jacket permits temperature control while testing. Ranges: *nD*, 1.30000-1.70000 to 4th decimal; *nF-nC*, 0-0.0500; Brix 0-95 percent.—*E. J. Van der Leur, 60 Beaver St., New York 4, N. Y.*

For more information circle 276 on inquiry card.

Vacuum Pumps

New "Rotary Gas Ballast Pumps" are mechanical high-vacuum pumps which will pump condensible vapors,

such as water vapor, without oil contamination or loss of pumping capacity; are offered in single-stage units with capacities ranging from 2 to 400 cfm., compound units (2 to 15 cfm.), and combination units (30 to 400 cfm.)—*National Research Corp., 70 Memorial Drive., Cambridge, Mass.*

For more information circle 277 on inquiry card.

ELECTRICAL INSTRUMENTS

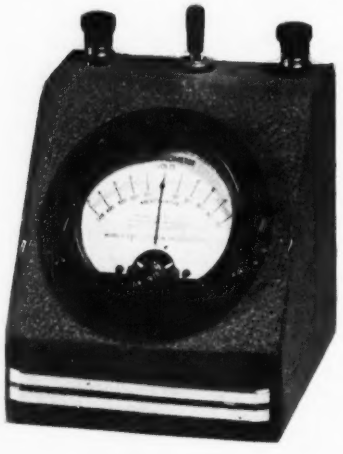
Shock-proof Oscillograph

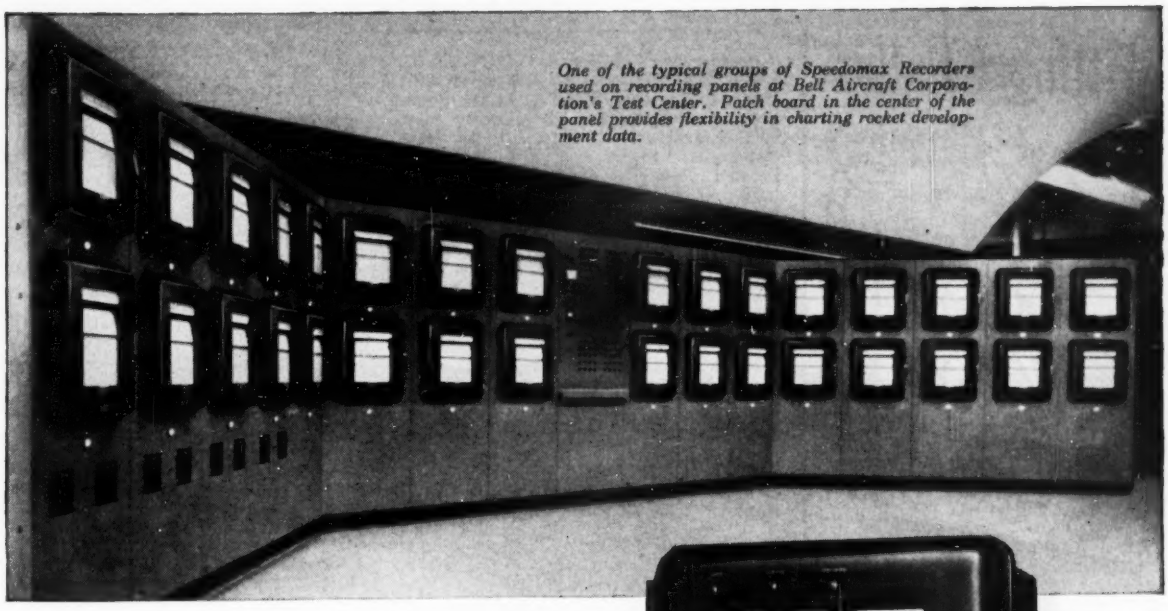
New "Model 560" oscillograph continues to record while subjected to 100-*G* single-phase and 500-*G* two-phase shock tests. Standard record speeds, 0.39 and 1.5 in./sec. (0.25 to 12.0 in./sec. with separate motor and additional gears). Up to 14 channels with maker's "Models 102 and 106" galvanometers having natural frequencies up to 3500 cps. Record width, 3.62 in. Magazine capacity, 50 ft. of Kodak "Linagraph 809" paper. Instrument weighs 8.25 lbs. without paper, operates on 24 v.dc.—*Midwestern Geophysical Lab, 3401 S. Harvard, Tulsa, Okla.*

For more information circle 278 on inquiry card.

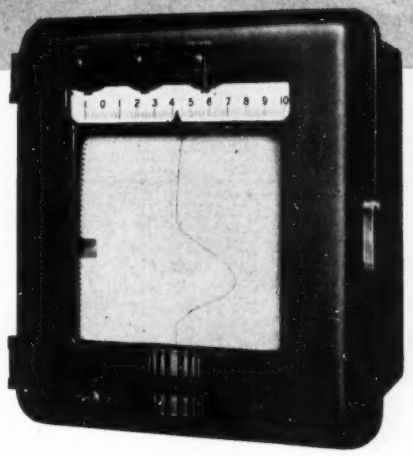
Galvanometers

New "Type W" galvanometers are zero-center d-c. double-scale indicators, with a 5-0-5-volt scale at top.





One of the typical groups of Speedomax Recorders used on recording panels at Bell Aircraft Corporation's Test Center. Patch board in the center of the panel provides flexibility in charting rocket development data.



Just set the knobs at top of instrument for the desired range and zero, and this AZAR recorder is adjusted to your exact specs . . . spreads any millivolt value from one to twenty across the full chart width, for measuring Force, Weight, Temperature, Speed, Voltage or any condition which yields an electrical recorder signal.

COMPLEX ROCKET-TESTING ROUTINES

Simplified

by Speedomax® adjustable-zero adjustable-range Recorders

● Rocket engine development at Bell Aircraft Corp., of Buffalo, N. Y. involves several unique instrument requirements. The nature of rocket combustion problems demands highly versatile instruments . . . instruments that can be dial-set to meet a wide variety of new test conditions. Furthermore, the instruments must also simultaneously record a combination of motor parameters. The highly flexible Speedomax adjustable zero adjustable range (AZAR*) Recorder provides Bell with just the right instrument combination for speedy, accurate test results.

Data for use in the engineering, designing and testing of rocket motors are obtained from pressure, temperature, force and flow measurements. Electronic transducers provide a d-c voltage proportional to the quantity measured; this signal is relayed to the AZAR Recorders through the patching network located in the center of the panel.

Various types of primary elements are used because of the extreme ranges encountered. All recorders are read in millivolts and converted to the measured quantity during data reduction. Adjustment of the range and zero makes it possible to read any pre-selected portion of the instrument scale.

Duplicate information is relayed to remotely located consoles for the convenience of engineers at the test stands. This is accomplished by electrical signals fed from the retransmitting slidewires of the recorders. Jog pen (used at Bell for time correlation between machines) and other accessory features to meet individual requirements can be incorporated in the versatile AZAR Recorder.

A general description of this instrument is available, and will be especially useful if you can describe to us the nature of your recording problem. Contact our nearest office or write 4955 Stenton Ave., Philadelphia 44, Penna.

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Jrl. Ad. E.M.9(4)

For more information circle 50 on inquiry card.

You'll want to complete your data file with this handy, dual purpose catalog. Covers both parts specifications and technical information on Koncentrik flared-tube fittings . . . the only line that gives you DOUBLE protection against dangerous leaks with the patented, Teflon-reinforced seat. Over 1200 combinations listed, for tubing through 1" O.D. Literature also available covering Powell valves with machined-in Koncentrik connections. Write today.

THE SPECIAL SCREW PRODUCTS CO.

5445 Dunham Rd., Bedford, Ohio

For more information circle **51** on inquiry card.

NEW INSTRUMENTS

Three types are available with 500-0-500, 100-0-100 and 25-0-25 microampere movements. Momentary readings on either scale may be taken by medium pressure on switch lever, left or right; full pressure locks switch in either position.—*Borden Engineering Co., New Providence, N. J.*

For more information circle **279** on inquiry card.

Galvanometer Unit

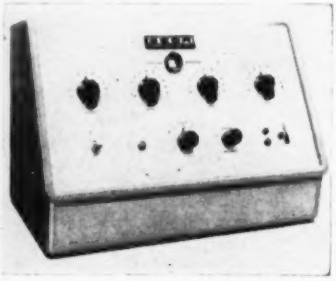
New single-element supersensitive galvanometer is suitable for school laboratory demonstrations and ballistic measurements in industrial labor-

atories. It weighs 24 oz. and is 5 in. high by 4 in. square at base. D-c. sensitivity is 15 in. deflection per microampere at 1 meter. Natural frequency is 1 cps. and d-c. resistance is 4000 ohms. (Other frequencies and sensitivities available.)—*Technical Instrument Co., 3732 Westheimer Rd., Houston 6, Texas.*

For more information circle **280** on inquiry card.

Impedance Bridge

New "M1 GEDA" impedance bridge can be used with precision by personnel unfamiliar with electronic cir-

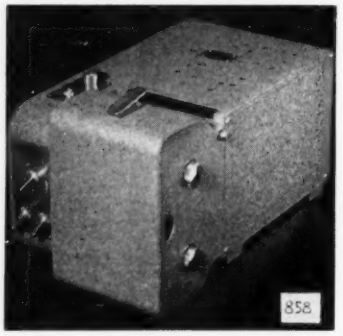


cuits; has no sensitivity controls; combines Wheatstone and Schering bridges; was designed especially for use with maker's linear and nonlinear analog computers but can be used in all fields requiring direct readings of resistance and capacitance. Resistance ranges 0-1 and 0-10 megohms; maximum error 0.15 percent or 100 ohms with probable error of less than 0.1 percent. Maximum capacitance measurement is 1 microfarad; error 0.25 percent or 0.0001 uf with probable error of less than 0.2 percent.—*Goodyear Aircraft Corp., Akron 15, Ohio.*

For more information circle **281** on inquiry card.

Multi-speed Oscillograph

New "Model 580" oscillograph takes 100 ft. of Kodak "Linagraph 809" paper or equivalent; has record speeds



of 1, 3, 6.5, 13 and 32 in./sec.; traces paper-width timing lines at 0.01- or 0.1-second intervals; has capacity for up to 14 galvanometers.—*Midwestern Geophysical Lab., 3401 S. Howard, Tulsa, Okla.*

For more information circle **282** on inquiry card.

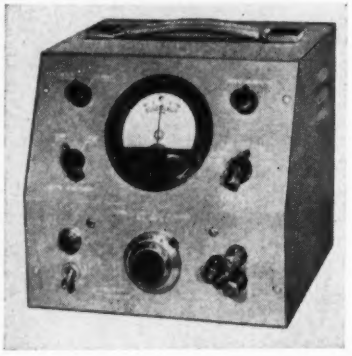
Oscilloscope Probe Set

New "Series SP-5 Oscilloscope Test Probe Set" comprises four test probes for general purpose as well as specialized TV signal-tracing, alignment, trouble-shooting and waveform analysis; also coaxial cable, connector, etc. Vinyl-plastic case rolls up compactly.—*Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst 17, N. Y.*

For more information circle **283** on inquiry card.

Laboratory Standard D-c. Voltmeter

New "Model PVM-4" laboratory standard d-c. voltmeter has resolution of better than 50 mv. over its entire 0-600-volt range and better than



5 mv. in 0-10-volt range. Accuracy is within 0.2 percent; linearity within 0.1 percent; input impedance infinite. Instrument consists essentially of a power supply, calibrated attenuator and a null indicator. Power supply reference voltage is furnished by a mercury battery with better than 1 percent per year stability. An internal Weston standard cell is provided for periodically calibrating power supply to within 0.1 percent of absolute value.—*Computer Corporation of America, 149 Church St., New York 7, N.Y.*

For more information circle **284** on inquiry card.

TV Microwave Equipment

New "KTR-100 Microlink" weighs less than 200 lbs., permits TV and audio coverage on short notice; con-

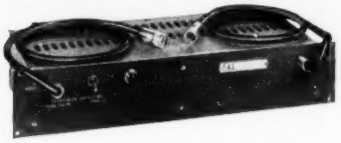
911

sists of two parabolas and four cases; has completely new AFC and limiter and temperature-controlled fused-quartz cavity; operates in 6875-7125-Mc. band.—*Raytheon Mfg. Co., Waltham 54, Mass.*

For more information circle 285 on inquiry card.

TV Chain Amplifier

New "Model 212A-TV Chain Amplifier" has a bandwidth of 40 to 225 Mc.; is designed specifically for TV

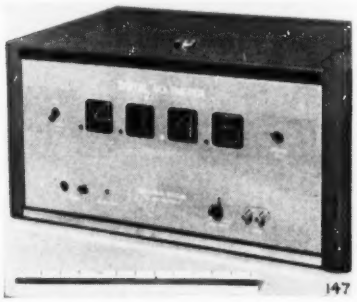


distribution system requirements. Up to twelve VHF TV channels can be amplified simultaneously with high fidelity.—*Spencer-Kennedy Laboratories, Inc.,* 186 *Massachusetts Ave., Cambridge* 39, *Mass.*

For more information circle 286 on inquiry card.

Direct-reading Voltmeter

New "Digital Voltmeter" indicates voltages in decimal or binary numerical digits. Among features: (1) Up to 100 separate readings per second; (2) does not use stepping switches or servo-driven VDR; (3) four-digit in-line readout indicates measured voltage with an error less than 0.1 percent of input reading or 0.00075 volts whichever is greater. (4) 10-meg input impedance; (5) decimal point shifts automatically with no manual range switching to provide continuous range from 0.001 to 999.9 volts; (6) non-cyclic operation—will follow continuous input changes up or down;



147

Measure and Record Strain with PRECISION

6-channel unit

The Hathaway TYPE RS-10 PRECISION STRAIN INDICATOR

6, 12, 25 or 50 Channels

FOR PRECISION MEASUREMENTS OF STATIC STRAIN

Static strain in 1 to 50 channels can be measured in rapid succession. Individually-calibrated 21-inch dial provides an accuracy of ¼ percent. Smooth and accurate balancing controls for each channel. Continuously-variable gage-factor adjustment.

FOR RECORDING DYNAMIC STRAIN

The RS-10 can be used with an oscillograph (such as the Hathaway type S14-C) for recording dynamic strain, providing *accurate balancing* and means for *precision calibration of the records.*

MULTI-CHANNEL PRECISION MEASUREMENTS OF STATIC STRAIN

DYNAMIC STRAIN RECORDING TO 300 CPS WITHOUT AMPLIFIERS

Write for Catalog Sheet 3H4L for details.

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For more information circle 52 on inquiry card.

GRIP ON

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with the NEW *AUTOMATIC* PICK-UP TWEEZER

A practical, versatile, ALL STAINLESS STEEL instrument designed to make the handling of small objects an easier, less time consuming operation.

Indispensable for picking-up, positioning or holding hot, sterile, highly polished, or oddly shaped objects and for getting into hard to reach spaces.

Pressing the plunger causes 3 Strong, Hooked, Spring Steel Fingers to extend from the tip and flare out.

Releasing the plunger causes them to withdraw. Any object within their grasp is then firmly held WITHOUT CONTINUED FINGER PRESSURE.

Send for your Tweezers of a thousand uses today, and see how and where this practical versatile tool can aid you:

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- Laboratory situations
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For more information circle **53** on inquiry card.

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES

Read by Sight, Sound or Feel.

- **Permanently Accurate**
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- **Faster—Easier to use**
- **Automatic Release**
- **All Capacities**

in inch ounces . . . inch pounds . . . feet pounds (All Sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

Sturtevant Co.

For more information circle **54** on inquiry card.

NEW INSTRUMENTS

(7) instant verification of calibration against internal standard cell and discretely-variable reference system: if a difference occurs, reference is made to balance input through a logically-sequenced millisecond relay computer. Models are available with outputs for operating electric typewriters or other storage devices, and with automatic polarity indication.—*Non-Linear Systems, Del Mar, Calif.*

For more information circle **287** on inquiry card.

Radar Range or Time-base Calibrator

New "Model 531 Precision Range Calibrator" is said to be "by far the most precise, versatile and dependable device of its kind in the market today." It may be used as a bench unit or in a tea-wagon arrangement for lab or field use. Among features: independent use of coincidence circuit, provision for external trigger, self-contained calibrator and precision regulated power supplies.—*Bristol Engineering Corp., Lincoln Ave., & Pond St., Bristol, Penna.*

For more information circle **288** on inquiry card.

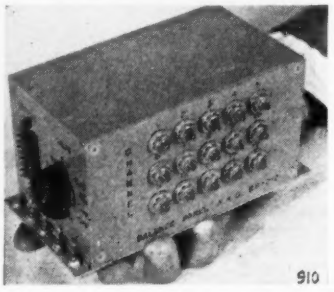
Sound-effects Filter

New "Model 6517-E" sound effects filter has two finger-tip controls to provide continuous instantaneous change of low and high cutoff frequencies; is designed for insertion upon cue; has one key for inserting filter into circuit momentarily and another key to use high and low frequency sections independently or in combination.—*Cinema Engineering Co., Burbank, Calif.*

For more information circle **289** on inquiry card.

Electrical Balance Panel for Multi-channel Systems

New "Model BP-2" fifteen-channel miniature balance panel is said to be unique in that it is constructed entirely of miniaturized components: weight and size reduced by a factor of six (or more). It is designed for use in flight test instrumentation, etc., where multiple-channel data recording is required and where weight and size must be minimized: bridge circuits involving strain gages, accelerometers, position pickups, etc. It incorporates miniature ten-turn balancing voltage dividers which have a linearity of 0.5 percent. Calibrating resistors of 0.1-percent accuracy are supplied.—*American Helicopter Co., Inc.*, 1800 *Rosecrans Ave., Manhattan Beach, Calif.*



For more information circle **290** on inquiry card.

Servo Amplifier

New "434-B" servo amplifier features use of transistors and of magnetic circuitry; is hermetically sealed; drives BuOrd MK14 and MK7 400-cps. servomotors from synchro data in a positional loop; is self-contained, requires no power supply or damping tachometer; has six connections (2 inputs, 2 outputs, 2 for 117-v. 400-cps.); weighs 17 oz. Among characteristics; zero maintenance, operation under shock or gunfire; low internal heat dissipation; no null-point drift with temperature and line voltage; no warm-up time. It is claimed to be "ideal for industrial application." Its circuitry can be modified for speed and temperature controllers, clutch amplifiers, alarms, etc.—*Industrial Control Co., Wyandanch, L. I., N. Y.*

For more information circle **291** on inquiry card.

Receiver for WWV

New "Model WWVR" receiver makes it possible to refer instruments to standard transmissions of NBS's WWV at any time without special set-up. Three plug-in front ends permit instantaneous switching to optimum frequency; highly selective audio system can be switched in for noise-free presentation of standard audio frequencies; three individual inputs for tuned antennas; four tuned circuits at signal frequency, sensitivity better than one microvolt on all frequencies. —*Specific Products*, 5864 *Hollywood Blvd., Hollywood* 28, *Calif.*

For more information circle **292** on inquiry card.

Ammeter Shunt Box

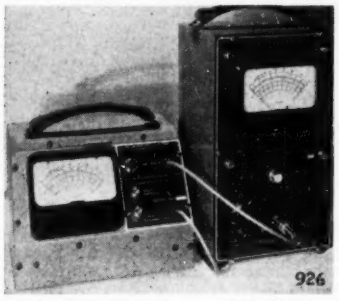
New "Type MV-121" shunt box, when plugged into maker's "12A"

voltmeter, converts it into an a-c. ammeter covering unusually wide frequency range.—*Millivac Instrument Corp., 444 Second St., Schenectady 6, N. Y.*

For more information circle 293 on inquiry card.

Overload Limiter

New "Type MV-174" overload limiter is for protection of such instruments as maker's "17B" and "17BX"



high-impedance d-c. millivoltmeters when used as null detectors.—*Millivac Instrument Co., 444 Second St., Schenectady 6, N. Y.*

For more information circle 293 on inquiry card.

Instrument Inverter

New "Type MV-123" instrument inverter permits making d-c. measure-

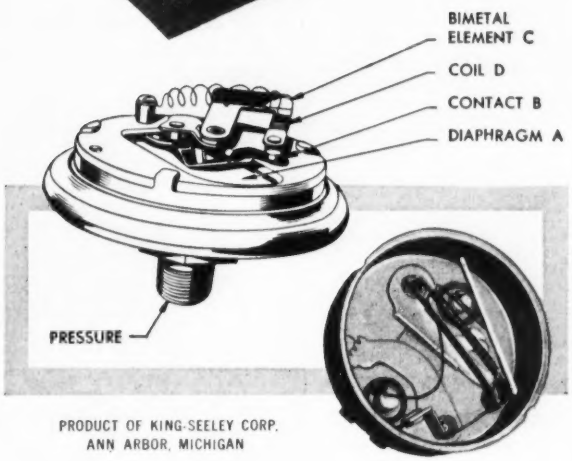
ments with sensitive VTVMs.—*Millivac Instrument Co., 444 Second St., Schenectady 6, N. Y.*

For more information circle 293 on inquiry card.

Telephone Noise Suppressor

New "Model SNS" noise suppressor allows satisfactory operation of any open-wire telephone circuits which have become inefficient or inoperative

CHACE BIMETAL DOES DOUBLE DUTY IN THE Telegage



PRODUCT OF KING-SEELEY CORP. ANN ARBOR, MICHIGAN

This electric oil pressure "Telegage," manufactured by King-Seeley Corporation, illustrates a use of thermostatic bimetal known as the "double bimetal circuit." Diaphragm A is subjected to the engine oil pressure. The diaphragm movement forces grounded contact B against the insulated contact on the "U" shaped bimetal element C. As the current flows through the circuit, the coil D heats the element, causing it to bend back, opening the contacts momentarily. The bimetal cools in an instant and again the contacts close.

The dash unit encloses a similar bimetal element and coil. Since both heater coils are in the same circuit, a similar bending of the bimetal occurs and the linkage moves the needle accordingly. When oil pressure increases, the bimetal element C is heated more in order to open the contacts; and this same increased heat causes a greater movement of the needle.

Chace Application Engineers, recognized authorities on temperature responsive devices, are available for consultation on your problems in temperature-actuated devices. Chace Thermostatic Bimetal is available in 29 types in strips, coils, random long lengths and welded or brazed sub-assemblies. We invite you to write for our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

For more information circle 55 on inquiry card.

High-altitude Recording

To record cosmic ray information, a leading university found that Alfax alone allowed them to build a recorder light enough to go up in a balloon and get the information.

ALFAX RECORDING PAPER

For the first time there is available an indelible recording paper—ALFAX—that is NOT subject to humidity, temperature or capillary action problems usually associated with pen and ink or papers marked by arcing or heat.

ELECTRICITY IS THE INK THAT MARKS ALFAX

Alfax paper can be marked by current as low as one volt and is instantaneous, permanent and stable. Highly sensitive Alfax is capable of catching transients and has a tone response capable of fourteen steps by simply varying the current through the paper.

Alfax is the only paper that is capable of high speed recording, stable before or after recording, is non-transferable, has low current consumption at high speeds, can record at high humidity over all temperature ranges, is smudge proof and non-toxic, widths from ¼" to 72".

Alfax opens a whole new field of monitoring and recording of phenomena which never before have been done easily and cheaply.

Request Booklet—describe your problem

Alfax Paper & Engineering Co.
Alden Research Center, Westboro, Mass.
ENGINEERING SERVICE TO RECORDER MANUFACTURERS

For more information circle 56 on inquiry card.

You are in good company when you choose

WABASH HYDRAULIC LABORATORY PRESSES

. . . Because many of the country's foremost industries, laboratories, schools and colleges have selected Wabash presses . . . the presses of 101 uses. Made in sizes from 3 to 50 tons, and with a variety of accessories for testing, laminating, filtering, extracting, forming and many other uses.

12 TON

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- PRECISION BUILT
- STURDILY MADE
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The New Econopress

A 3 ton model attractively priced for use where a larger model is not needed. Has all the high quality features that have made Wabash presses so outstanding.

For more Information WRITE . . .

WABASH METAL PRODUCTS CO.
Hydraulic Division, Wabash, Indiana

For more information circle 57 on inquiry card.

NEW INSTRUMENTS

by reason of induced toll circuit noise. It is an electronic device designed to change signal-to-noise ratio on telephone circuits, thereby reducing noise heard by listener without reducing volume of talker's voice to listener. Installation of "SNS" can be made at a fraction of cost of alternative solutions for placing phantom circuits back in operation.—*Special Products Co., 9115 Brookville Rd., Silver Spring, Md.*

For more information circle 294 on inquiry card.

Pocket-size Volt-ammeter

New "Amprobe Junior," latest addition to maker's line of snap-around

volt-ammeters, is available in models for 10, 25, 50 and 100 amps. (0-125/250 volts.).—*Pyramid Instrument Corp., Lynbrook, N. Y.*

For more information circle 295 on inquiry card.

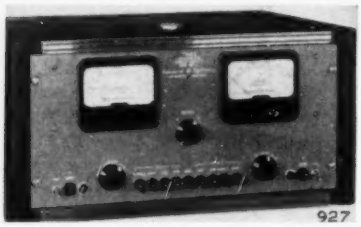
Airborne A-c. Generator

New induction a-c. generator for airborne use weighs 4.75 lbs.; is less than half the size of an ordinary automobile generator; withstands 50*G* shock and 40*G* acceleration.—*AiResearch Mfg. Co., Los Angeles, Calif.*

For more information circle 296 on inquiry card.

Twin Regulated Power Supply

New "Model 520AT" features two separate regulated power supplies, each giving 0 to 500 v.dc. at 0 to 200

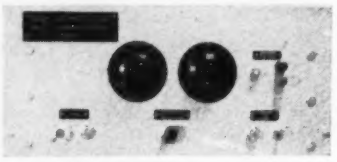


ma. at any setting; each floating above its chassis, hence usable in various ways to give positive or negative outputs or connected in series to give 0 to 1000 volts at 0 to 200 ma. Also furnished are two 6.3 v.ac. outputs at 8 amps. each.—*Universal Electronics Co., 2012 So. Sepulveda Blvd., Los Angeles 25, Calif.*

For more information circle 297 on inquiry card.

Regulated Power Supplies

New "Beva Models 300 and 301 Precision Power Supplies" are for use in proportional counting and in con-



junction with pulse height analyzer systems, mass spectrographs, etc. Output voltage for "Model 300" is from 500 to 1600 volts d.c.; "Model 301" from 1000 to 5100 volts d.c. Maximum output current for both units is 1 ma. Regulation is 0.01 percent for load variation from 0 to 1 ma. and for line voltage change from 105 to 130 volts.—*Instruments & Equipment, Inc., 489 Fifth Avenue, New York 17, N. Y.*

For more information circle 298 on inquiry card.

Regulated H-v. Power Supply

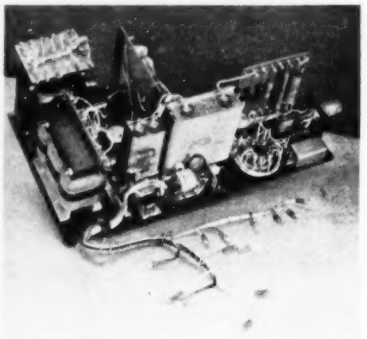
New "PS-71" regulated high-voltage d-c. power supply has output of 1000 to 1500 volts conservatively rated

for 1-ma. load. Absolute value of output voltage is adjusted by precision resistance network, changes less than 0.005 percent from zero to full load or when input voltage changes 10 percent. Ripple is less than 0.03 percent.—*Scientific Specialties Corp., Snow and Union Sts., Boston 35, Mass.*

For more information circle 299 on inquiry card.

X-ray Tube Current Stabilizer

New "Norelco" x-ray tube current stabilizer employs only one electron tube whereas early model used nine.



It has three ranges: 2-8, 8-35 and 30-50 ma. It holds emission current constant to within 1 percent.—*Research & Control Instruments Div., North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.*

For more information circle 300 on inquiry card.

General-use Pre-amplifier

New "Model 102B Decade Amplifier" has stabilized gains of 40 and 60 db and max. gain of approx. 80

db; max. output 50 volts rms. into 20,000 ohms or higher load, 10 ma. into low impedance. Weight 25 lbs.—*Kalbfell Laboratories, Inc.*, 1090 *Morena Blvd., San Diego* 10, *Calif.*

For more information circle **301** on inquiry card.

ELECTROMECHANICAL COMPONENTS

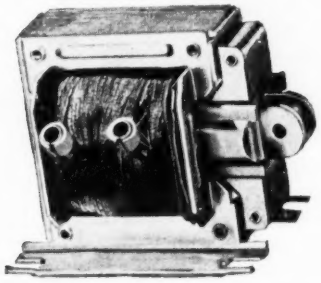
Low-speed Motors

New "S-200 Series" of "Circle B" synchronous motors, are available at speeds from 10 rph. to one revolution per month. Size: 2 in. diameter by 1.62 in. deep. Torque limited by gear train to 1 in.-lb. continuous, 5 in.-lbs. intermittent use.—*Bristol Motor Div., Vocaline Company of America, Inc.*, 190 *Coulter St., Old Saybrook, Conn.*

For more information circle **302** on inquiry card.

Replaceable-coil Solenoid

New "2000 size C-T Design" solenoid, featuring coil which can be changed in field by removing two

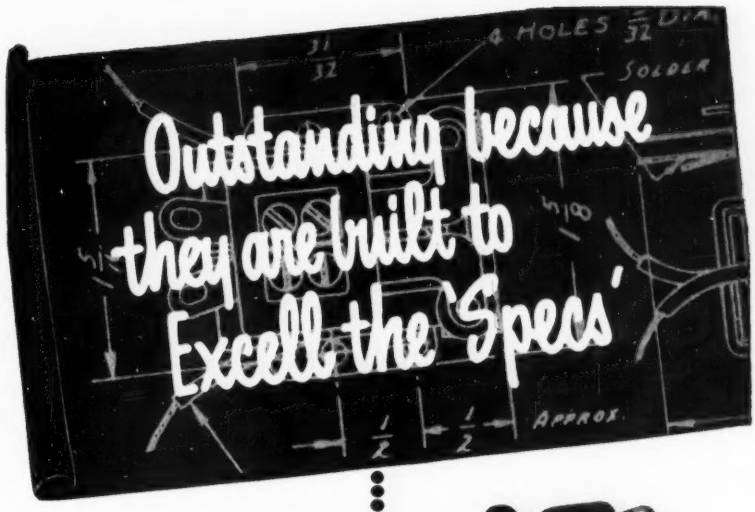


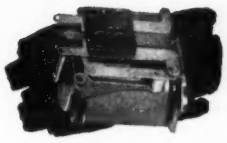
spring clamps, is available in two models: "No. 230" delivers approx. 6.5 in.-lbs. per stroke; "No. 231" 9.5 in.-lbs. Both can be supplied for any voltage rating at 50 or 60 cycles. Dimensions 2.06 x 2 x 0.75 in. exclusive of mounting flanges.—*Dormeyer Industries*, 3418 *N. Milwaukee Ave., Chicago* 41, *Ill.*

For more information circle **303** on inquiry card.

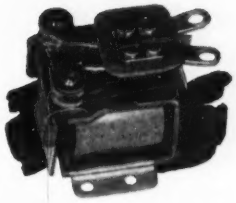
Dc.-to-A-c. Converters

New line of "Custom Converters" with manual frequency control are engineered for professional use and for broadcast tape recorders, measuring devices, etc. Recessed d-c. male

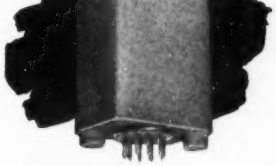




R 45 SERIES—Small telephone type relay with pin hinge construction. Available with multiple contact springs up to six pole double-throw. Capacities: 1 amp., 3 amp., or 5 amp. Normally supplied for D.C. operation. Hermetically sealed or open. 1-13/32x1-1/4x1-7/32 to 1-5/8 high.



R 83 SERIES—Available with A.C. or D.C. coils. Contact ratings up to 30 amperes continuous, 150 amperes inrush with single pole double-break arrangement. Multiple contact springs with proportionately lower ratings also available. Size: 1-7/8x1-5/16x1-5/8 high.



R 94 SERIES—Hermetically sealed small telephone type relay with pin hinge construction for long life. Available in D.C. only with contact springs up to 4 pole double-throw. In 1 amp., 3 amp., or 5 amp. capacity. Plug-in or solder terminals. Overall size 1-5/8 x 1-1/32 x 2-1/4 D.

RB 45 SERIES—Similar to R 45 with the exception that it is designed to fit the hermetically sealed enclosure shown. Three stud mounting; solder terminals. Available up to 4 pole double-throw. Widely used in aircraft and ground communication equipment. Size: 1-5/8 x 1-7/16x2-1/32 D.

"Diamond Quality" TIME SWITCHES...

Automatic Electric also produces a complete line of Time Switches and Timers, both manual and automatic reset. Write for information.

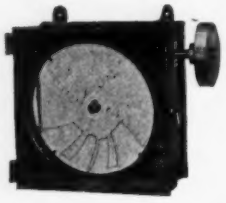
AEMCo

Automatic Electric MFG. CO.

58 STATE STREET MANKATO, MINN.

For more information circle **58** on inquiry card.

Amthor



Operation Speed Recorder 8" Chart 12 or 24 hr.

Built for severe service. Users report 10, 12 or more years of trouble-free life. Powerful centrifugal speed-measuring elements stays calibrated. Non-spill reservoir pen. Special chart paper. Rugged clock movement. Ideal for analysis of new War Effort jobs.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems. Drop us a line today.

Amthor Testing Instruments Co., Inc.
49a VanSinderen Ave. Brooklyn, N. Y.

For more information circle 59 on inquiry card.

for fast . . . accurate . . . engraving . . .

Pictured above is the PREIS-PANTO Model 2D-4 Precision Engraving Machine for use on large metal or plastic panels, signs and name plates; steel stamps and dies or any product requiring precision engraving.

PANTO

Write for 2D-4 Bulletin and prices

H. P. PREIS ENGRAVING CO.
661 U. S. Highway 22 Hillside, N. J.

For more information circle 60 on inquiry card.

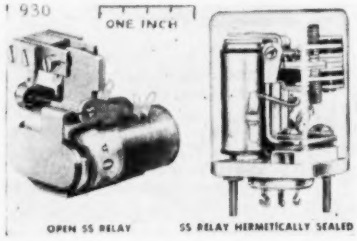
NEW INSTRUMENTS

plug is furnished for 32-, 64-, 115- and 230-volt d-c. input models. 12-, 24- and 28-volt models have heavy stranded input leads.—*Dept. 21, Carter Motor Co., 2644 N. Maplewood Ave., Chicago 47, Ill.*

For more information circle 304 on inquiry card.

Supersensitive Relays

New "SS Series" supersensitive relays, operating on 10 milliwatts or less with 10-*G* vibration resistance,



are equipped with s-p.d-t. pure silver contact combinations rated at 2 amps., 28 v.dc. or 115 v.ac. non-inductive.—*Potter and Brumfield, Princeton, Ind.*

For more information circle 305 on inquiry card.

Printed-circuit Rotary Switches

New "Type PCF-I" printed circuit rotary switch has 60 positions, shorting type action, unusual segment design whereby eyelets are provided for solder connections at every position. "Type PCF-2," having 30 non-shorting positions, is also available. Contact resistance is approx. 0.003 to 0.004 ohm and does not vary more than 0.0003 ohm over life of unit. Diameter is 3 in.—*The Daven Co., 191 Central Ave., Newark, N. J.*

For more information circle 306 on inquiry card.

MARK your products **ACCURATELY** with— **STEEL STAMPS**

HERCULES HOLDERS AND STEEL TYPE

ACROMARK Series 9A Marking Machines come in bench, foot, air and motor operated models.

Hundreds of these widely adaptable high production machines are in use and seldom require repair or service.

Very reasonably priced. Ask for literature and prices.

The ACROMARK Company
3-11 MORRELL ST.
ELIZABETH 4, NEW JERSEY
"The Original Marking Specialists"

For more information circle 61 on inquiry card.

E-1005

WHEATSTONE BRIDGE

ACCURACY 1/20 of 1%

Plug Type, Interchangeable Ratios
1, 10, 100, 1000, 10,000 Ohms
Bridge Arms, 5 Dials
10 × (.1 + 1 + 10 + 100 + 1000)

All resistors, seasoned Manganin; ample current carrying capacity.

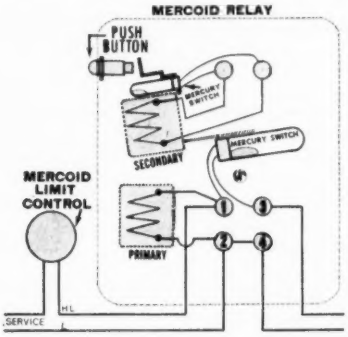
PRICE $275

GRAY INSTRUMENT CO.
64 W. JOHNSON ST. PHILA., PA.
ALSO OTHER MODELS
SEND FOR OUR CATALOG

For more information circle 62 on inquiry card.

Push Button Relay

New "Type V2X108" push button relay for audible alarm permits operator to manually interrupt an au-

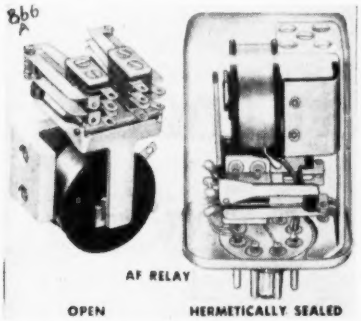


dible alarm and provides for alarm circuit to be automatically re-established as soon as condition requiring alarm has been corrected. Standard enclosure meets NEMA 1 requirements. Available in weather-proof enclosure.—*The Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.*

For more information circle **307** on inquiry card.

Aircraft Relays

New "AF Series" light-weight 400-cycle ac. relays, designed to withstand better than 10-*G* vibration in aircraft

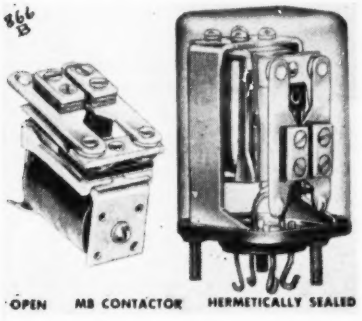


equipment, have two Form C fine silver contacts rated up to 5 amps. at 115 v.ac. or 28 v.dc. non-inductive load. Contact pressure is 15 grams or higher at approximately 2 va. input per pole.—*Potter and Brumfield, Princeton, Ind.*

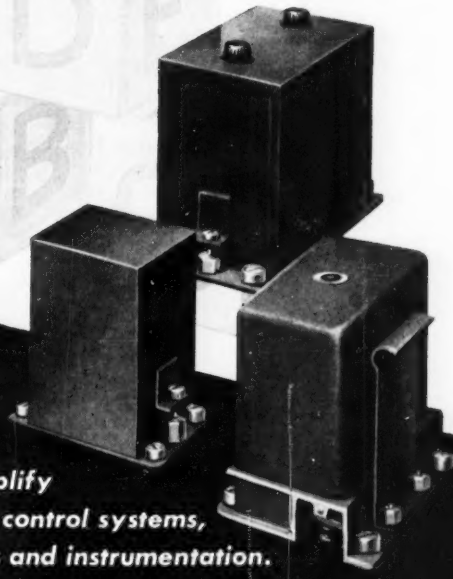
For more information circle **308** on inquiry card.

Miniature Contactors

New "MB Series" of miniature d-c. power contactors for high current applications in aircraft and similar



Electronic BUILDING BLOCKS



. . . to simplify electronic control systems, computers and instrumentation.

Servomechanisms, Inc. "building block" or packaged function technique reduces intricate "all in one" systems into simple, standard electronic components which plug into pre-wired chassis. This advanced design philosophy provides ***reliability, interchangeability, and ease of maintenance.***

The same concept has been applied to Servomechanisms, Inc. expanding line of transducers..

Universally accepted and proven in combat these building blocks are available for 60 and 400 cycle applications. Write to Dept. CLO 4 for complete information.

A typical Servomechanisms, Inc. analog computer and transducer for aircraft instrumentation.

SERVOMECHANISMS INC.

Westbury Division
Post and Stewart Aves., Westbury, N. Y.

El Segundo Division
316 Washington St., El Segundo, Calif.

POSITIONING MECHANISMS • SERVO AMPLIFIERS • MODULATORS • POWER SUPPLIES
SERVO MOTORS • ADAPTERS • TRANSDUCERS • MECHANICAL DEVELOPMENT APPARATUS

For more information circle **63** on inquiry card.

News in 1940—production necessity today

ONLY a few years ago, the science of sensitive, accurate measurement was limited to laboratories. But today, this science is practiced every day in thousands of industrial plants by factory men . . . who don't have to be instrument experts.

Production men wanted to put this science to work, for they had long known that many processes would function at greater efficiency if temperature, pressure and other variables could be more accurately maintained. Although these potential benefits could be proved in the laboratory or in pilot plants, they could seldom be exploited fully in actual production.

Milestone in measurement

One of the main reasons was that existing industrial methods of measurement were not sufficiently accurate, sensitive or fast. Instruments with delicate mechanical balancing systems suffer inherent limitations . . . always require a compromise between sensitivity and ruggedness . . . and can provide only periodic measurements.

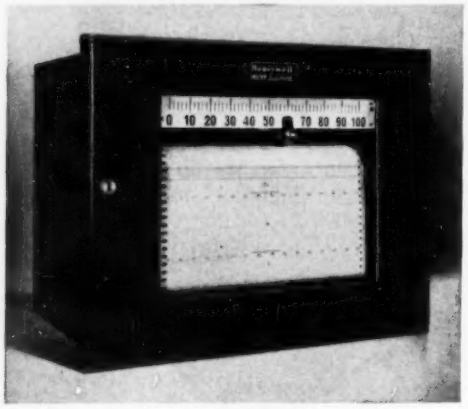
Then, in 1940, the advent of *ElectroniK* instruments swept away these limitations. By adopting an entirely new approach—electronic continuous balancing—these instruments revolutionized the concepts of industrial measurement. They placed laboratory accuracy and sensitivity at the disposal of the production man . . . with all the simplicity and ruggedness demanded by industrial service . . . *plus* speed of response never before economically practical.

Proved by years of performance

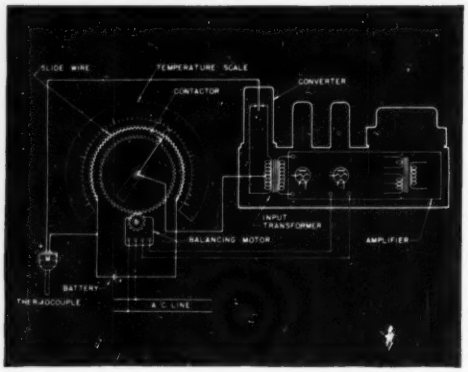
In the past thirteen years, thousands of plants have discovered almost endless applications where the superior performance of these instruments helps to improve operations. The more they learn about *ElectroniK* instruments, the more they call on them for increasingly complex tasks of measurement and automatic control.

Since 1940, the *ElectroniK* family has grown to encompass a host of new indicating, recording and controlling models . . . capable of measuring scores of different process variables . . . equipped with the most advanced types of automatic control. In anticipation of the needs of the future, Honeywell's intensive development program is bringing to readiness even more advanced equipment for tomorrow's process control problems.

Big furnaces with

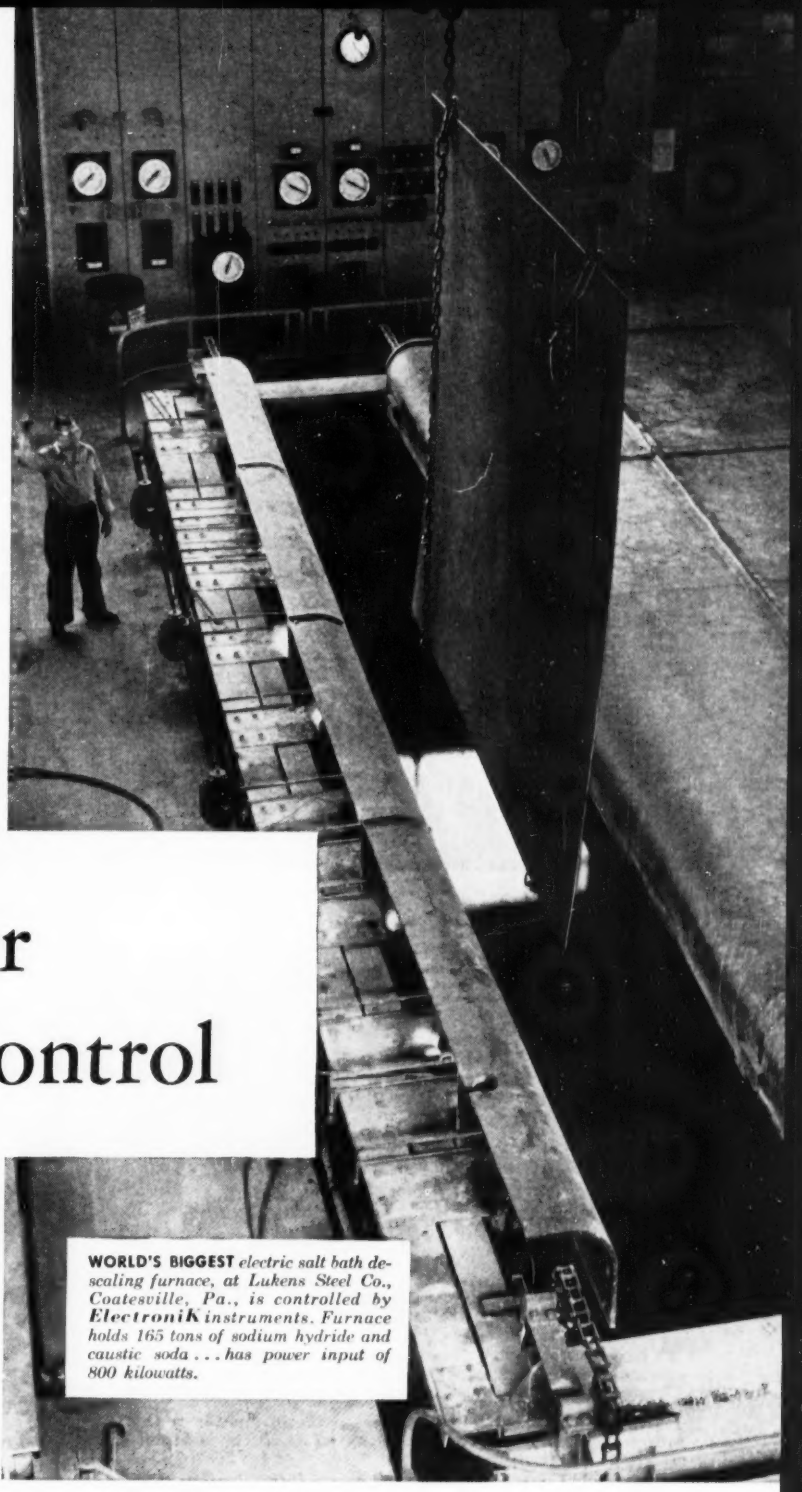


A FAMILIAR SIGHT *to thousands of production men, scientists and engineers is this strip-chart* **ElectroniK** *Recorder, one of a complete family of indicating, recording and controlling instruments.*



POWER PLANT *of* **ElectroniK** *instruments amplifies a millionfold the minute electrical signals from thermocouples and other sensing elements.*

For more information circle 64 on inquiry card.



TYPICAL of today's trend to greater plant capacity is the huge sodium hydride descaling furnace which Lukens Steel Co. uses to clean hot-rolled clad sheets. For this critical operation, *ElectroniK* instruments once more were chosen to regulate vital furnace temperatures.

On load after load, the *ElectroniK* controllers hold bath temperatures exactly at the specified value . . . prevent overheating which might cause warping and under-heating which would slow production. *ElectroniK* accuracy pays dividends, in greater output and in top quality of finished sheets. And *ElectroniK* industry-proved design assures uninterrupted operation of this critical process.

Throughout the steel industry . . . applied to blast furnace, open hearth, soaking pit, reheating, annealing and other furnace control, you'll find thousands of these instruments performing with the highest efficiency.

produce better *ElectroniK* control

When you're planning new facilities, or modernizing existing equipment, plan on utilizing the proved performance of *ElectroniK* instrumentation. Call your Honeywell engineer for experienced consultation . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

WORLD'S BIGGEST *electric salt bath descaling furnace, at Lukens Steel Co., Coatesville, Pa., is controlled by* **ElectroniK** *instruments. Furnace holds 165 tons of sodium hydride and caustic soda . . . has power input of 800 kilowatts.*

● **REFERENCE DATA: Write for new Catalog 1530—"*ElectroniK* Controllers."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

For more information circle 64 on inquiry card.

THIS IS IT!
World-wide recognition for this outstanding line of electric soldering irons—
HEXACON
— specified by the big names for the TOUGH JOBS!
★ MINNEAPOLIS HONEYWELL
★ RADIO CORP. OF AMERICA
★ STROMBERG-CARLSON
★ WESTERN ELECTRIC
★ WESTINGHOUSE
★ EMERSON
★ KAISER
★ BENDIX
★ SPERRY,
etc.
PLUG OR SCREW TIPS
40 to 700 Watts
⅛" to 1¼" Tip Dia.
Follow the leaders and you'll specify HEXACON! They'll efficiently solve your soldering problems too! Write for literature.
Here's the famous
HEXACON HATCHET TYPE
These irons feature better balance for reduced operator fatigue. Efficiency is stepped up, and quality of work is improved. The ideal iron for inaccessible and intricate jobs.
HEXACON ELECTRIC CO.
179 W. CLAY AVE. ROSELLE PARK, NEW JERSEY

For more information circle 65 on inquiry card.

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DEPENDABLE
Instrument
Operation
You Must Have
CLEAN-DRY
AIR
When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.
Dryers are offered with manual, semi-automatic or fully automatic control. Heat regeneration of desiccant is supplied by either electricity or steam.
An Industrol Dynamic Dehumidifier used in conjunction with the Industrol Centrisorb Filter is the ideal combination to give you the clean, dry air that spells trouble-free instrument operation.
Prove to yourself why more plant operating men are specifying Industrol. A qualified engineer is available to consult with you on your dryer problems.
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SUBSIDIARY OF
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494 Westfield Ave., East • Roselle Park, New Jersey

For more information circle 66 on inquiry card.

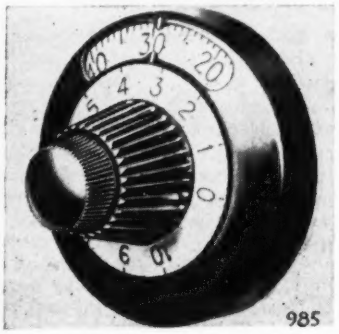
NEW INSTRUMENTS

equipment have 0.25-in. pure silver contacts and solid silver shorting bar rated at 60 amps. 28 v.dc. non-inductive load. Contact arms are heavy brass with large, tinned solder terminals. Contact arrangement is s-p.s-t., normally-open double-make. Contact pressure is of order of 250 grams.—*Potter & Brumfield, Princeton, Ind.*

For more information circle 307 on inquiry card.

Ten-turn Counting Dial

New "Microdial 746-B" ten-turn counting dial can be friction-locked in any fixed position by turning an externally-mounted knob; may be used



on any multi-turn device having ten turns or fewer; has two concentrically mounted dials—one for counting increments of 0.01 turn and the other for counting turns. It indicates contact position to an indexed accuracy of 0.1 percent.—*Borg Equipment Div., The George W. Borg Corp., Janesville, Wis.*

For more information circle 310 on inquiry card.

Coaxial Switch

New "Model DOY 3AA" manually-actuated coaxial switch, for 3⅛-in. rigid-line TV applications, has 1.1 max. wswr. at up to 320 Mc.; weighs about 27 lbs.—*Electronics Div., Thompson Products Inc.,* 2196 *Clarkwood Rd., Cleveland* 3, *Ohio.*

For more information circle 311 on inquiry card.

Subminiature Hermetically-sealed Connectors

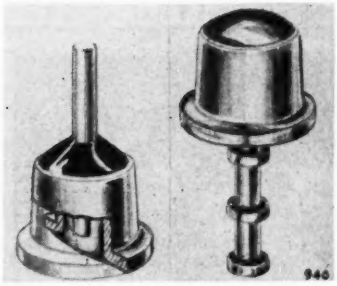
New "U Series" of subminiature connectors, in round shell design, are for use on miniature sealed and un-

sealed instrument switches, relays, transformers, amplifiers, etc.; are made in 3- and 6-contact arrangements (single-contact and 12-contact types in near future). Contacts are for 5 amps., with a minimum flashover of 1,700 v.dc.—*Cannon Electric Co.,* 3203 *Humboldt St., Los Angeles* 31, *Calif.*

For more information circle 312 on inquiry card.

Sealed Stand-offs

New line of hermetically-sealed stand-offs in three series comprising 12 models is said to be complete. Each series features two pin treatments—



straight wire or double turret head. Pins may extend from either flange side or barrel side of an eyelet. With these locations, junction points may be above or below a panel; and locations permit eyelet flanges to remain on one side of panel, facilitating solder assembly of eyelets to panel. Each stand-off is a complete glass-to metal fully-insulated sealed unit.—*The Fusite Corp., 6000 Ferview Ave., Cincinnati 13, Ohio.*

For more information circle **313** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

Long-life Thyratrons

New "Types 6268 and 6279" are improved versions of standard hydrogen thyratrons "4C35 and 5C22," incorporating self-contained and self-regulating sources of hydrogen; minimum life expectancy over 1000 hours (at least twice that of standard types).—*Amperex Electronics Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.*

For more information circle **314** on inquiry card.

Tetrode Amplifier

New "Type 6BQ6G" tetrode beam power amplifier designed for service as a horizontal deflection amplifier in TV receiver sweep circuits, is similar to "Type 6BQ6GT" except for increased bulb size: better safety margin for dissipation.—*Radio Tube Div., Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.*

For more information circle **315** on inquiry card.

Germanium Diode

"Type 1N133" germanium diode has been especially manufactured and tested to meet requirements for mixer applications in UHF TV spectrum of 470 to 890 Mc. Among features: glass-filled phenolic case and special impregnation for optimum performance under adverse humidity conditions.—*Hytron Div., Columbia Broadcasting System, Inc., Danvers, Mass.*

For more information circle **316** on inquiry card.

Junction Transistor

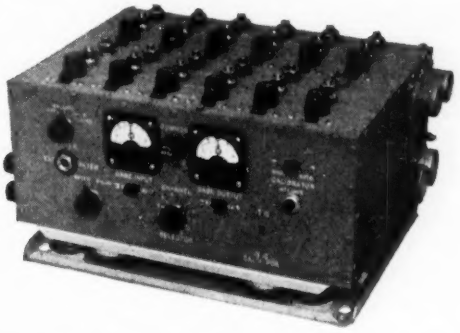
New hermetically-sealed junction transistor operates efficiently in temperatures as high as 212 F. and under severest humidity conditions. Small quantities will be made available to development laboratories and engineering groups.—*General Electric Co., Electronics Park, Syracuse, N. Y.*

For more information circle **317** on inquiry card.

Germanium Transistors

New transistors, marking maker's entry into this field, comprise four types: (1) "Type 2N32" is a point-

Century MODEL 1809
BRIDGE CONTROL UNIT
FOR VIBRATION AND STRESS ANALYSIS

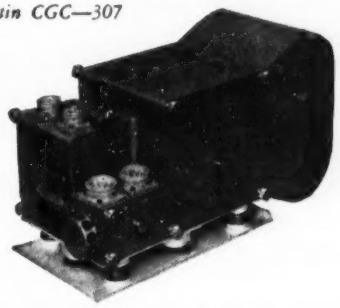


Designed as a companion unit to Century's famous Model 409 Oscillograph, the Model 1809 Bridge Control Unit is the latest addition to Century's line of industry-standard vibration and stress analyzing equipment. Packaged in a small, compact space, the unit contains all of the facilities necessary for use with 12 channels of resistance strain gages or bridge-type transducers. Where used with the Model 409 Oscillograph, it is necessary only to connect strain gages and power source to have a complete stress-strain measuring and recording system, small and rugged enough to be placed in an aircraft wing tip or guided missile warhead.

FEATURES:
Size: 4½" x 7" x 11".
Weight: 10½ pounds.
Aluminum case.
Up to 12 channels.
For any resistance strain gage or bridge-type transducer.
May be used with direct indicating instrument.
Power: Control unit, 22-28 Volt D.C.
Strain gage, 6-28 Volt D.C.

Write for Bulletin CGC—307

MODEL 409 OSCILLOGRAPH



The Century Model 409 Oscillograph has been designed for recording data where space and weight requirements are limited. The Oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:
Size: 5" x 6 15/16" x 11 15/16".
Weight: 13 pounds.
Cast aluminum case.
Paper speeds variable ½" to 6" and 2" to 24" per second.
Detachable daylight loading magazine with a capacity of 3⅝" x 100' paper.
2 to 14 individual channels.
Trace identification.
Trace viewing.

Write for Bulletin CGC—303

Century GEOPHYSICAL CORPORATION
TULSA, OKLAHOMA
4447 No. Bodine, Philadelphia 40, Pa. | 3406 W. Washington Blvd., Los Angeles 18, Calif. | 238 Lafayette St., Dayton 2, Ohio | 309 Browder St., Dallas, Texas | EXPORT OFFICE 149 Broadway, N. Y. City

For more information circle **67** on inquiry card.

designed for

exacting

pressure applications

HEISE GAUGES

STANDARD OF THE WORLD

THE CHOICE of Bourdon tubes used in Heise Gauges is governed by pressure medium and pressure range. An infinite number of Bourdon tube designs is available to meet exacting requirements for accuracy and stability in many pressure media, including mercury.

There are no stock gauges. Every Heise Gauge is manufactured on special order. Ranges: 0-15 to 0-10,000 psi. Sizes: 8½", 12" and 16". Prices: $151.60 to $211.20. Gauges for use with mercury are $20.00 extra. Write for catalog.

Heise Bourdon Tube Company, Inc.
Newtown, Connecticut

For more information circle 68 on inquiry card.

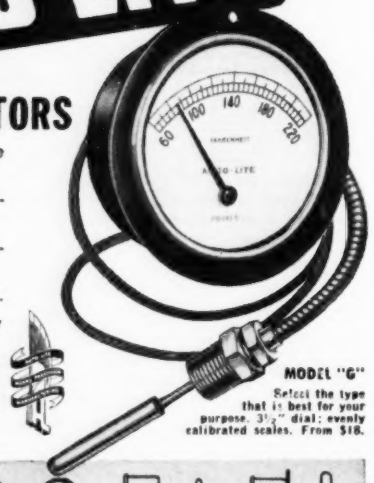
For Eye-Level Readings...

AUTO-LITE

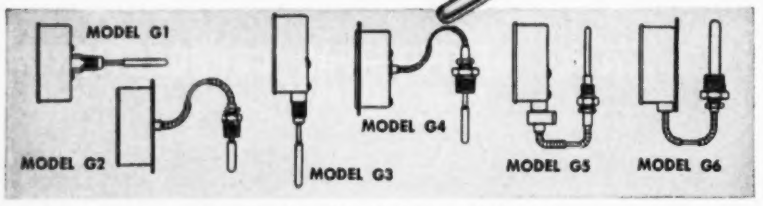
TEMPERATURE INDICATORS

- Precision-built indicators provide accurate temperature readings.
- Low-cost protection . . . due to large, specialized production.
- Wide selection of dial ranges to meet specific requirements.
- Choice of stock types available as shown.
- Send for new catalog, describing many thermometer styles.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

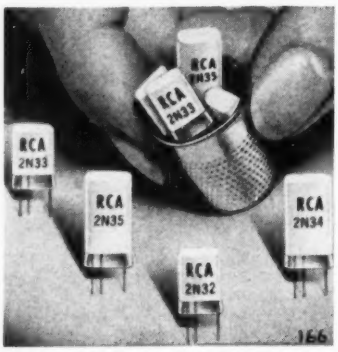


MODEL "G"
Select the type that is best for your purpose. 3½" dial; evenly calibrated scales. From $18.



For more information circle 69 on inquiry card.

NEW INSTRUMENTS

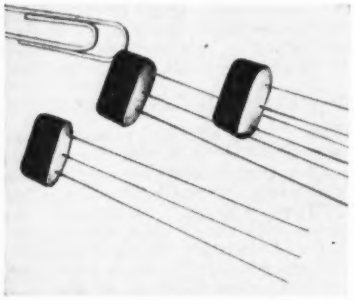


contact transistor with high current amplification for pulse or switching applications; (2) "Type 2N33" is a point-contact transistor for oscillator applications up to 50 Mc.; (3) "Type 2N34" is a junction transistor, *p-n-p* type, for low-power low-frequency applications; (4) "Type 2N35" is a junction transistor, *n-p-n* type, for low-power low-frequency applications. *—Tube Dept., Radio Corp. of America, Harrison, N. J.*

For more information circle 318 on inquiry card.

Junction Transistors

New "Types RD2520 and RD2525" grown-junction *n-p-n* transistors have current sensitivities (alphas) of 0.95

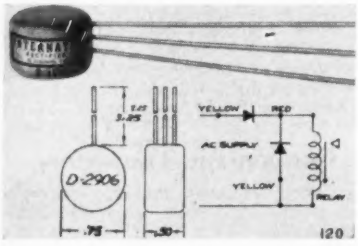


and 0.99 respectively, latter believed to be highest commercially available. Made by Germanium Products Corp.; sold exclusively by *Federated Semi Conductor Co., 66 Dey St., New York 7, N. Y.*

For more information circle 319 on inquiry card.

Relay Rectifier-suppressor

New "Type D-2906" rectifier-suppressor for use with d-c. relays, encapsulated for complete protection against moisture, fungus, salt spray and corrosive vapors, consists of two elements, one providing half-wave rectification of a-c. input and the other



providing a path for current resulting from collapse of relay's magnetic field during non-conducting half-cycle, whence chatter-free operation of relay. Unit is rated 48 volts maximum input and 5 ma. output in 100 deg. C. —*International Rectifier Corp.*, 1521 *E. Grand Ave., El Segundo, Calif.*

For more information circle 320 on inquiry card.

Rectifier Kit

New "Build-It-Yourself Rectifier Kit" is made up of major parts of a rectifier, with illustrated instruction

sheet. Available in ranges from 2 to 12 amps. at 110 to 220 volts.—*Electronic Rectifier Co., Rochester, N.Y.*

For more information circle 321 on inquiry card.

Single-turn VDR

New "Model Y Series Helipots" are voltage-dividing resistors of 1.75-in. diameter, available in five mounting styles: threaded bushing mount, servo flange mounting or two-hole servo mounting with either sleeve bearings or ball bearings. Fool-proof external phasing clamp permits simple and accurate phasing in the field. As many as 14 sections may be ganged on a single shaft; as many as 17 taps per section may be made. Units are available from 50 to 50,000 ohms, 2.5-watt rating. Standard linearity tolerance 0.5 percent; 0.25 percent on special order.—*Helipot Corp., South Pasadena, Calif.*

For more information circle 322 on inquiry card.

Paper Capacitors

New "Meteor Type ADZ" paper capacitors providing operation from —65 C. to 125 C. without derating are available in JAN-C-25 bathtub case styles CP-53 to CP-55, with glass-to-metal terminals, in extended-foil non-inductive type construction; in multiple- and single-section capacitors.—*Astron Corporation, 255 Grant Avenue, East Newark, N. J.*

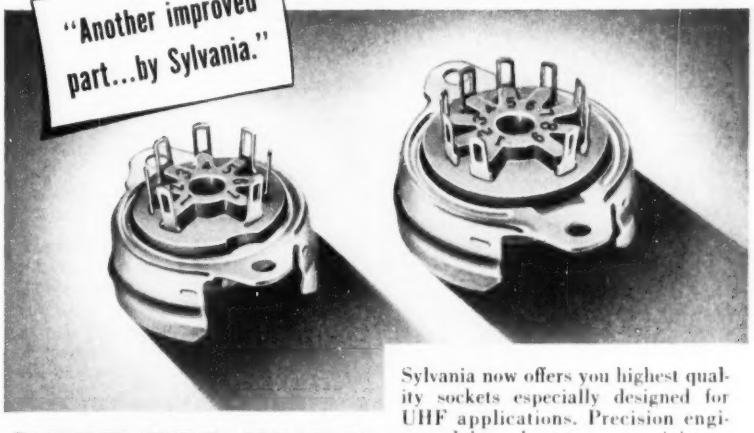
For more information circle 323 on inquiry card.

Electrolytic Capacitor for Transistor Circuits

New "Type EHT" high-purity tantalum-foil electrolytic capacitor for use in audio transistor circuitry has lead wires securely welded to foils; solderable leads (tin-coated nickel) welded to tantalum leads external to capacitor body to preserve minimum

Ultra High Quality Sockets

FOR UHF APPLICATIONS



Sylvania now offers you highest quality sockets especially designed for UHF applications. Precision engineered throughout to assure minimum inductance.

Shield bases and contacts cadmium plated. Low-loss phenolic castings completely inclose tube pins to prevent shunted circuits. For detailed information: Sylvania Electric Products Inc., Dept. 3A-4206, 1740 Broadway, N. Y. 19, N. Y.

SYLVANIA

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St., Montreal, P. Q.

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For more information circle 70 on inquiry card.

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high-precision thermistors

Whether you use these temperature responsive resistors in standard or special models, you can be sure of this. *They'll match your needs* for resistance values, size, temperature coefficient, mountings and quality. Made in our own plant under carefully controlled conditions, Bendix-Friez Thermistors know no equal.

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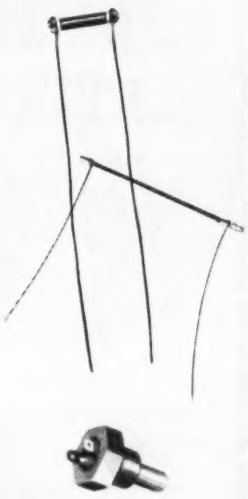
Size (inches)	@ +30°C.	@ 0°C.	@ −30°C.
.140 x .75	45.0 ohms	86 ohms	194 ohms
.040 x 1.5	12,250 ohms	26,200 ohms	65,340 ohms
.018 x 1.5	35,000 ohms	82,290 ohms	229,600 ohms

Write for details.



Used in this typical application for sensing the temperature of hydraulic oil.

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Minimum Pressure Drop
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Automatic or Manual Control
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of any metal or rubber-lined in sizes to 120"

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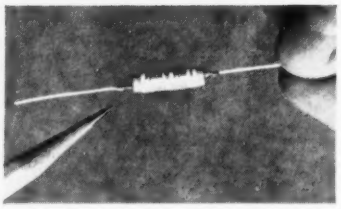
For more information circle 74 on inquiry card.

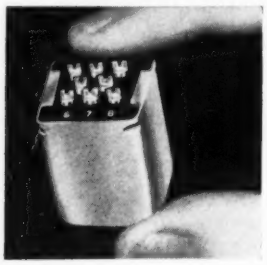
NEW INSTRUMENTS



leakage current necessary in transistor circuits.—*Sangamo Electric Co., Marion, Illinois.*
For more information circle 324 on inquiry card.

Audio Transformers

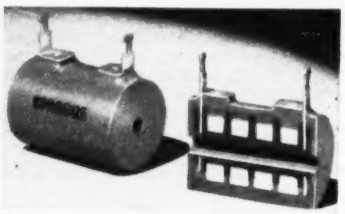
New "Stancor Tinytrans," miniature high-fidelity audio transformers, are made with nickel-steel lamina-



tions, with frequency response of plus and minus 1 db, 30-15,000 cps., maximum level 0 db.—*Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill.*
For more information circle 325 on inquiry card.

High-wattage Resistors

New "Durameg Accurate Wirewound Resistors" are of radically new construction with ceramic-insulated



"Ceron" resistance wire and truly-molded casing, so that wattage ratings at 105 C. (221 F.) are four to five times the 85 C. MIL-R-93A ratings.—*Sprague Electric Co., North Adams, Mass.*
For more information circle 326 on inquiry card.

Sealed Resistors

New sealed precision resistors, immune to immersion and high humidity, meet all requirements of MIL-R-93A and JAN-R-93. Operating temperature —65 C. to 125 C. Units have reversed and balanced PI windings for low inductance. Exclusive features: internal section cross-over wire is insulated from winding by a 2,000v. insulation; special metal molded connecting feature bonds end of winding and terminal in a non-corrosive and mechanically secure manner.—*Mepco, Inc., Morristown, N. J.*
For more information circle 327 on inquiry card.

Low-torque VDR

New "Type 1418" voltage dividing resistor, offered with shaft torque as low as 0.025 oz.-in., was developed for use in computers and fire-control equipment. Units are available with resistance values between 100 and 350,000 ohms, rated at 3 watts, electrical rotation up to 360 deg., choice of taps and brushes, linearity to 0.1 percent and resolution down to 0.03 percent.—*Electro-Mec Laboratory*, 19 *Murray St., New York 7, N. Y.*

For more information circle **328** on inquiry card.

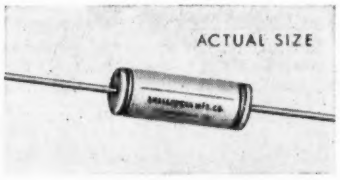
High-wattage Resistors

New "Type G" precision resistors utilize fiberglass-insulated wire to increase wattage ratings 5 to 10 times over those of commercial precision wirewounds of same dimensions. (E.g., "Type G-196E" dissipates 8 watts and standard "Type 196" 1 watt.) Units are available in all standard bobbin sizes and ratings from 1 to 20 watts. —*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **329** on inquiry card.

Quarter-watt Resistor

New "Type 18" axial lead precision wirewound resistor for subminiature electric and electronic equipment is



rated at 0.25 watt; non-inductive winding; standard tolerance of 1 percent; resistance values up to 400,000 ohms.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **330** on inquiry card.

Fixed Resistors with Strengthened Leads

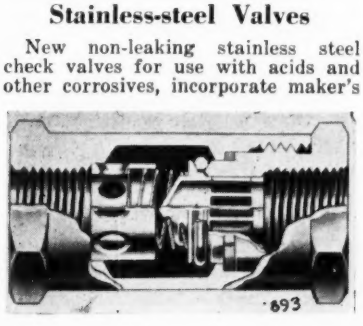
New "Super Davohm Precision Wire Wound Resistors" have an additional stranded lead wire between resistance wire and terminal, so that no matter how much stress, heat or pressure is applied to solder terminal, no accompanying shock is put upon fine resistance wire itself.—*The Daven Co.*, 191 *Central Ave., Newark 4, N. J.*

For more information circle **331** on inquiry card.

VALVES, TUBING, ETC.

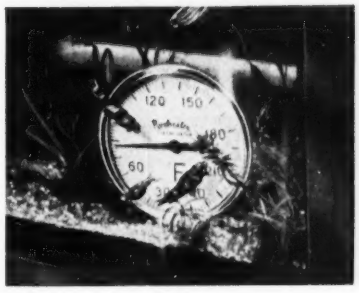
Stainless-steel Valves

New non-leaking stainless steel check valves for use with acids and other corrosives, incorporate maker's



Prevent thermometer fogging

No matter how long you dunk it, you can't cloud the accuracy of a Rochester dial thermometer.



THIS SUBMERSIBLE QUALITY is important to you. It means fast, easy temperature readings . . . without any danger of a foggy crystal causing inaccuracy. Rochester dial thermometers are assembled and hermetically sealed in a special humidity-controlled "dry" room. This eliminates any possibility of condensation inside the thermometer.

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EXCLUSIVE OUTSIDE RECALIBRATION— Rochester makes the *only* industrial thermometer that can be recalibrated from outside the case. If an extremely hard blow should knock it out of adjustment, you can have it back on the job in less than a minute . . . without taking the thermometer apart or breaking the hermetic seal.

You can order Rochester thermometers from one of our specialized instrument representatives listed in Sweet's Catalog. Or write direct for full details.

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For more information circle **75** on inquiry card.

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- **Glass to metal seal under controlled humidity and temperature conditions.**
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For more information circle **76** on inquiry card.

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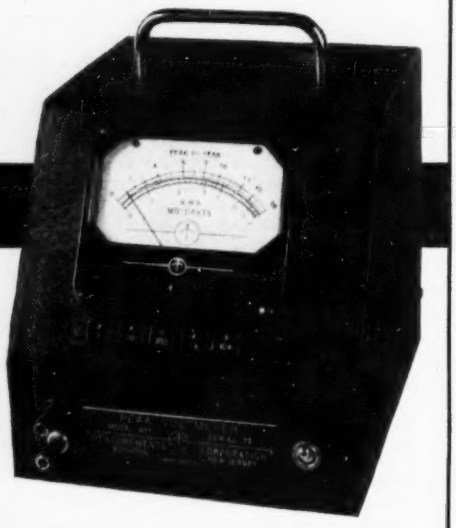
Peak-to-Peak VOLTMETER

.0005—300 VOLTS



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Designed for accurate indication of the peak-to-peak values of symmetrical and asymmetrical waveforms, varying from low frequency square waves to pulses of less than five microseconds duration.

.0005-300 volts peak-to-peak, .0002-100 volts r. m. s. in five ranges. Semi-logarithmic, hand calibrated scales.

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INPUT IMPEDANCE: 1 megohm shunted by 30 mmfd.
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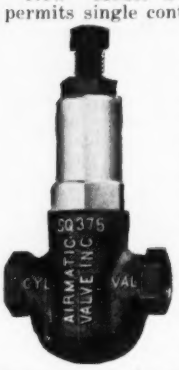
For more information circle 79 on inquiry card.

"Circle-Seal" principle but employ Teflon "O" rings and gaskets; are supplied in various grades depending on required service, with male tube or female pipe connections.—*James-Pond-Clark, 2181 East Foothill Blvd., Pasadena 8, Calif.*

For more information circle 332 on inquiry card.

Sequence Valve

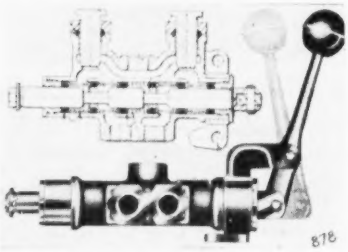
New "Model SQ" sequence valve permits single control of multi-operations, enabling operation of two or more cylinders, in their correct sequence without manual handling; handles pressures from 20 to 200 psi. air, oil or water; is available in six standard pipe sizes from 0.25 in. to 1.25 in.—*Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.*



For more information circle 333 on inquiry card.

Air Control Valve

New air control valve has two speed controls built into valve body. Principal use is to control air cylinder

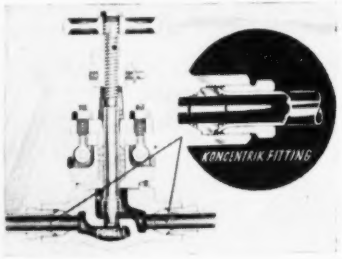


stroke. Among claimed advantages: (1) no purchase or installation of separate speed controls; (2) simple piping; (3) cost halved. Available in standard 4-way piped exhaust model; actuator may be knob, lever, clevis, treadle, foot, cam, cylinder, solenoid, and diaphragm.—*Valvair Corp., 962 Beardsley Ave., Akron, Ohio.*

For more information circle 334 on inquiry card.

Tube-connection Valves

New models of "Powell Valves," in stainless or Monel, are available with machined-in "Koncentrik" flared-tube



connections for tubing through 1-in. OD, obviating need for adaptors or back-welded assembly. Valves stocked for prompt shipment include needle, globe, gate and check.—*The Special Screw Products Co., 5445 Dunham Rd., Bedford, Ohio.*

For more information circle **335** on inquiry card.

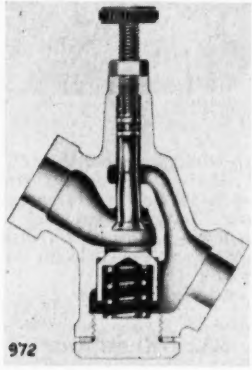
Thermostat-type Automatic Reseating Relief Valves

New "Type V" series of "Econo-Therm" relief valves for hot-water storage heaters have thermostat device which allows water above 208 F. to escape, in addition to standard pressure relief setting of 125 psi., (other setting to order.)—*A. W. Cash Valve Mfg. Corp., Decatur 60, Ill.*

For more information circle **336** on inquiry card.

Piston-speed-control Valve

New "Speed Control Valve" is said to "provide split-second timing of piston movement by positive control



of air flow." It can be mounted in any position between operating valve and cylinder. Feature is ease of adjustment, accomplished by many turns on stem.—*Ross Operating Valve Co., 120 E. Golden Gate, Detroit 3, Mich.*

For more information circle **337** on inquiry card.

Tube Fittings

New fittings added to maker's line are: (1) "Swagelok Cap" for capping end of tube; (2) "Swagelok Plug" for plugging unused port of fitting. Both come completely assembled; are available in a wide variety of sizes from ⅛-in. up in brass, aluminum, steel, stainless steel and Monel.—*Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio.*

For more information circle **338** on inquiry card.

Instrument-tubing Harness

New corrosion-proof instrument-tubing harness is available in two types, each in several sizes. (1) "Dekoron Impervapak Poly-Cor" is composed of a bundle of polyethylene tubes

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—in a wide variety of designs, sizes and materials.

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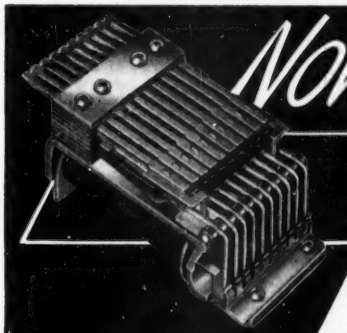
For more information circle **80** on inquiry card.



NOW... for the first time KELLOGG magnetic impulse counter

- The long life normal to relay equipment!
- Occupies the space of only two telephone relays!
- Operates over the same wide range of pulse ratio and frequency as a chain of well-designed counting relays!

It's simple! It saves space! It saves money! . . . Actuated by electrical impulses, the *Kellogg Magnetic Impulse Counter* performs the counting and marking function of a chain of 10 to 20 relays or of a two-magnet ten-point stepping switch, in less space and with top reliability! It has a wide application in many fields—from industrial control to any system where trains of impulses, such as generated by a telephone dial are to be counted.

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For more information circle **81** on inquiry card.

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A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

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For more information circle 82 on inquiry card.

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DEPTH & ABSOLUTE PRESSURE
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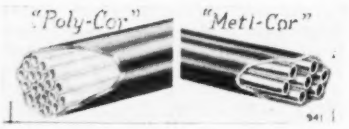
For more information circle 84 on inquiry card.

NEW INSTRUMENTS

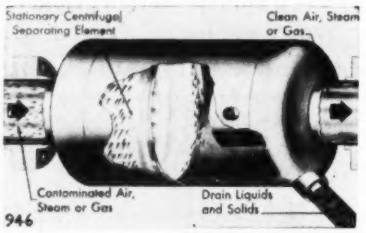


over which is extruded a 1/16-in. sheath of black polyethylene plastic of high molecular weight. Standard sizes have 4, 7, 10, 14, or 19 tubes of ¼-in. OD having a ⅛-in. bore; special sizes available. Individual tubes are color coded in black, brown, blue and natural. (2) "Dekoron Impervak Metl-Cor" likewise has 1/16-in. polyethylene sheath but contains 4, 7 or 10 METAL tubes of ¼-in. or ⅜-in. OD. Pressure-tight fittings are available for joining successive lengths of harness.—*Dekoron Tubing Div., Samuel Moore & Co., Mantua, Ohio.*

For more information circle 339 on inquiry card.

Air Cleaner

New line type "Hi-eF Purifier" is said to remove "virtually 100 percent of all dirt, oil, moisture and guck



even at extreme velocities and pressures." It is made in all standard sizes up to 24 in. for pressures up to 600 psig. Larger sizes and special designs made to specs.—*Purifier Div., V. D. Anderson Co.*, 1935 *W. 96th St., Cleveland 2, Ohio.*

For more information circle 340 on inquiry card.

Air Regulator

New "Type HAA" regulator has a capacity of 80 cfm. at 100 psi. line pressure. Feature is use of air pressure against regulating diaphragm

instead of conventional spring-loaded diaphragm. Thus air flow increases as demand increases without affecting set pressure. Maximum pressure which can be regulated is 135 psi. and maximum line pressure 300 psi.—*The DeVilbiss Co.*, 300 *Phillips Ave., Toledo 1, Ohio.*

For more information circle 341 on inquiry card.

INSTRUMENT EVENTS Calendar

June 15-20, 22-25
University of Michigan courses in Automatic Control. For information write M. H. Nichols, Rm. 1523, E. Engineering Bldg., University of Michigan, Ann Arbor, Mich.

June 30-July 11
Second British Instrument Industries Exhibition, National Hall, Olympia, London, England. For information write E. L. Bols, Grand Buildings, Trafalgar Square, London, W.C.2, England.

July 20-31
Special summer program in Transistors, Massachusetts Institute of Technology. For information write Massachusetts Institute of Technology, Cambridge 39, Mass.

July 20-31
Boston College course in Industrial Spectrography. For information write James J. Devlin, S. J. Physics Dept., Boston College, Chestnut Hill 67, Boston, Mass.

July 27-31
Gordon Research Conference on Instrumentation, Colby Junior College, New London, N. H. For information write W. George Parks, Director, Chemistry Dept., University of Rhode Island, Kingston, R. I.

August 10-14
Gordon Research Conference on Analytical Chemistry, New Hampton School, New Hampton, N. H. For information write W. George Parks, Director, Chemistry Dept., University of Rhode Island, Kingston, R. I.

August 19-21
IRE Western Electronic Show and Convention, Municipal Auditorium, San Francisco, Calif.

August 24-26
Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, W. Va. For information write G. W. Stuart, Equitable Gas Company, 3325 Hyperion St., Pittsburgh 14, Penna.

September 9-11
Conference on Nuclear Engineering, University of California. For information write R. A. Fayram, University of California, Berkeley, Calif.

September 21-25
Eighth National Instrument Conference & Exhibit, Sherman Hotel, Chicago, Ill. For information write P. V. Jones, Mgr., Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Pa.

September 22-25
Third Biannual meeting of the Chambre Syndicale Nationale de la Mechanique de Haute Precision "Importance of Measurements in Quality Control", Paris, France. For information write G. Dumez, President, 37 Avenue de Breteuil, Paris VII, France.

September 28-30
Ninth National Electronics Conference and Exhibition, Sherman Hotel, Chicago. For information write Karl Kramer, Executive Secretary, 852 E. 83 St., Chicago 19, Ill.

Oct. 14-16
Midyear Meeting of Recorder-Controller Section, SAMA, Seaview Country Club, Absecon, N. J.

October 30-31
Annual meeting of Pacific Coast Section, Society of Exploration Geophysicists, Statler Hotel, Los Angeles, Calif. For information write SEG, Box 7248, Tulsa 18, Oklahoma.

November 18-20
American Institute of Electrical Engineers Conference on Electronic Instrumentation and Nucleonics in Medicine, New York, N. Y. For information write Raymond C. Mayer Associates, 9 Rockefeller Plaza, New York.

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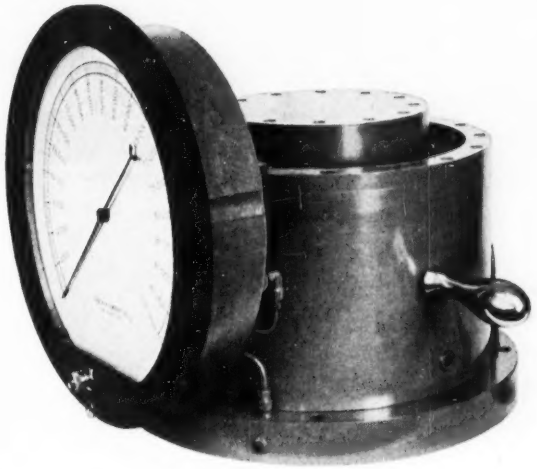

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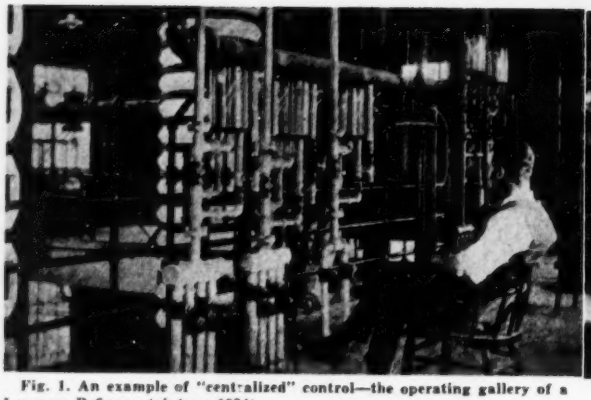

Fig. 1. An example of "centralized" control—the operating gallery of a Lummus Refinery (vintage 1924)

Fig. 2. Early control panel.

The Case of The GRAPHIC PANEL

By R. L. NICHOLS
Magnolia Petroleum Co.

A brief history of the growth of instrumentation shows the development of the graphic panel, which has both advantages and disadvantages.

GRAPHIC PANELS are but one more step in the centralization and improvement of the control of process variables. Years ago, when throughputs were small, batch processes the rule, and manpower was cheap, centralization was not a problem. When batch processes gave way to continuous systems the need for more centralized control began to appear. One refinery, built by the Lummus Company about 1924, came up with the "ultimate" in centralized control (Fig. 1) where all important readings and controls were within easy reach of the operator.

Control rooms with truly "centralized" controls soon came into being—pumps were located in the control room; flow was regulated by controlling the number of strokes per minute; important control valves were placed so that extension stems reached into the control room, terminating in large hand wheels; "cold junctions" were buried 14 feet underground and "cold junction" compensation was not necessary. All instruments, of course, were mounted on the front of the board (Fig. 2)—no flush mounts were available.

About 1930, a Cross Unit was built in Louisiana, and such complete instrumentation was installed that when Kellog's operating engineers brought the unit on stream it ran for over thirty days without requiring any adjustment by any operator. After the test (mark this, you who go all out for full panelliization and completely automatic control) some of the instruments were removed in order that the operator might be required to make certain adjustments by hand and thus keep in touch with the process.

The trend in refinery engineering has been, and still is, toward fully continuous units with small storage capacities between stages, but with greater and greater throughputs. Pneumatic controllers with various adjustable types of action, and control valves capable of equivalent response, have been developed to meet the ever-broadening demands of the process designers.

Presented at the Eighth Annual Symposium on Instrumentation in the Process Industries, Texas A & M College, College Station, Texas, January 1953.

Pneumatic Transmission Methods

Continuous processing demanded centralized control and central control rooms for efficient operation. This required the separation, sometimes by a considerable distance, of the instrument from the point of measurement. Pressure and differential-pressure lines soon became so long as to be impractical, as did the capillary lines for pressure-type thermometers. Over the years, therefore, pneumatic and electrical methods of transmitting measurement signals were developed and refined, and another era of change began.

The use of the various transmission systems allowed the control rooms to be completely removed from the operating area, with the added advantage that process fluids could be kept out of the control rooms, thus reducing fire hazards.

Fig. 3. One of the first miniature panel (M/P) control stations.

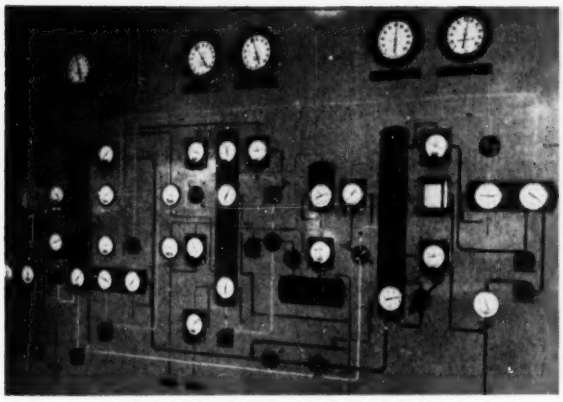

Fig. 4. Graphic panel with much detail.

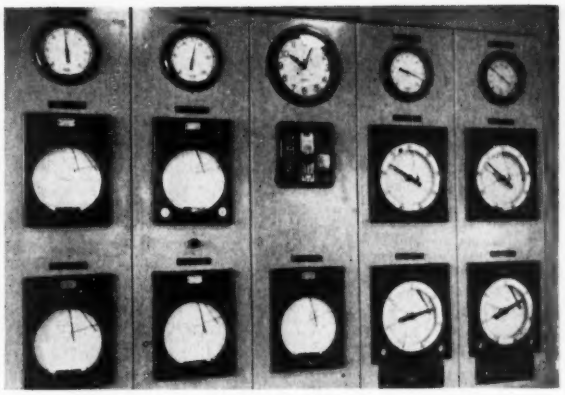

Fig. 5. Conventional panel for same process as for Fig. 4.

A disadvantage inherent in the use of centralized control panels with pneumatic transmission of measurement was the introduction of an appreciable time lag between the measuring element at the process and the indicator or recorder-controller on the panel board. A similar lag existed in the return circuit to the valve.

Another disadvantage was the excessive panel space required for the mounting of standard instruments. Control boards 100 feet in length were not uncommon, and control rooms were large in proportion. It became increasingly difficult for an operator to gain an over-all picture of process operations from row upon row of similar-appearing instruments on a long control board. Training of new operators became more difficult, and frequently additional manpower was required because of the "spread" of the panel.

Remote Stations

The logical answer to the lag problem was the location of the controller at the process, closely coupled to the measuring and controlling elements. In order to maintain centralized control, however, an indication or record of the variable was needed on the board. This led to the development of "blind" pneumatic controllers operating on a 3-to-15-psi. range, which were entirely separate from the indicating or recording instruments and connected into the system only by pneumatic tubing.

With a locally mounted controller and a board-mounted indicator or recorder, there was still need for adjustment of the set point and for manual operation from the control board in emergencies. The blind controllers, operating on a pneumatic-balance principle, were readily adaptable to these needs. In this system the measured variable is translated into a pneumatic pressure by a transmitter; the set point is also determined by a pneumatic pressure. These two air pressures are pneumatically balanced against air pressure to the control valve. Thus the transmitter and air-pressure regulator for the set point can be separated readily from the controller.

At this point the Remote Hand Control (with two gages) returned to the picture, disguised as an M/P station. The two gages were combined into one duplex gage; one point gave a continuous indication of the controlled variable, the other could be used to indicate the set-point pressure to the controller or the pressure to the control valve. The station included manual-to-automatic transfer switches and a pressure regulator which during automatic operation was used to adjust the set point on the controller. For manual operation this regulator was used to position the control valve. This unit was small—occupying approximately 4½ x 5 inches of panel space; Fig. 3 shows one of the first.

The small size of the indicating station permitted a much-needed reduction of control-board and control-room size. However, control boards using the miniature instruments crowded together were not completely satisfactory. A single operator could see more instruments and observe the behavior of more of the process variables, but he had more information available than he could effectively correlate or use.

The Graphic Panel

The next logical step was the introduction of the graphic panel. This term is generally used to describe a control panel which presents a simplified flow sheet of the process, with the major process vessels and equipment pieces represented by appropriately shaped symbols. The major process flows are represented by lines of various colors and widths. The various measuring and controlling instruments and alarm indications are placed in their proper positions in the flow diagram.

In another form, appropriate symbols are placed in the flow diagram, and similar symbols on the control stations, which are usually mounted below the diagram and directly below the reference marker.

There has recently come to notice another panel which the designers refer to as "semi-graphic." It has recording control stations mounted below the diagram. "Deviation" lights, which come on when any variable leaves the control point more than a predetermined amount, are mounted in the flow diagram and at the corresponding control station. This particular panel also includes an industrial TV installation, whose receiver is somewhat too large to include in the flow diagram!

Early graphic panels used the indicating, panel-mounted station. If charts were required, these indicators had to be paralleled by conventional recorders, usually located below the graphic section or on a wing panel which flanked the central graphic section. This duplication of indicators and recorders was eliminated by the introduction of the miniature recording station, which performs all the functions of the M/P and makes a record of the controlled variable on a narrow strip chart.

Time Lags and Control Modes

Temperature, liquid level, and pressure are characterized by long time-constants. These may use controllers mounted on the board. When the process variable has a short time-constant, however, as for flow, the transmission time-lag becomes all-important for optimum control.

Transmission time-lags are reduced by having the complete control loop at the process, with the control supervised from the M/P Station on the graphic panel. With the controller mounted at the process, a pneumatic cut-off relay automatically seals the output of the controller from the valve when the operator desires to load the valve manually.

For proper control, late designs of blind controllers provide all the accepted responses—proportional, rate, derivative, and inverse derivative in practically any combination desired. The trend, however, is toward simplification. Other instruments now available for use on graphic panels include graphic-type level indicators and various alarm

Continued on page 902

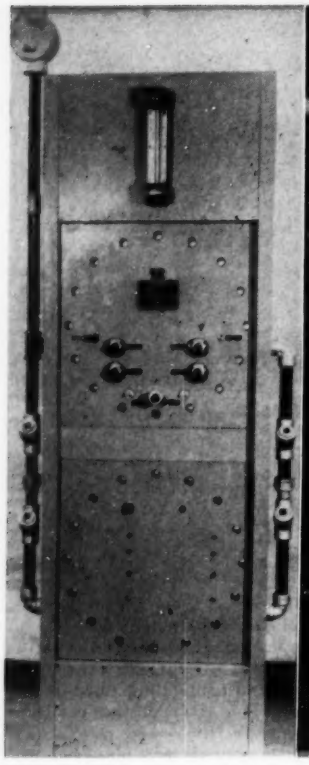

Fig. 1. Phillips automatic infrared analyzer.

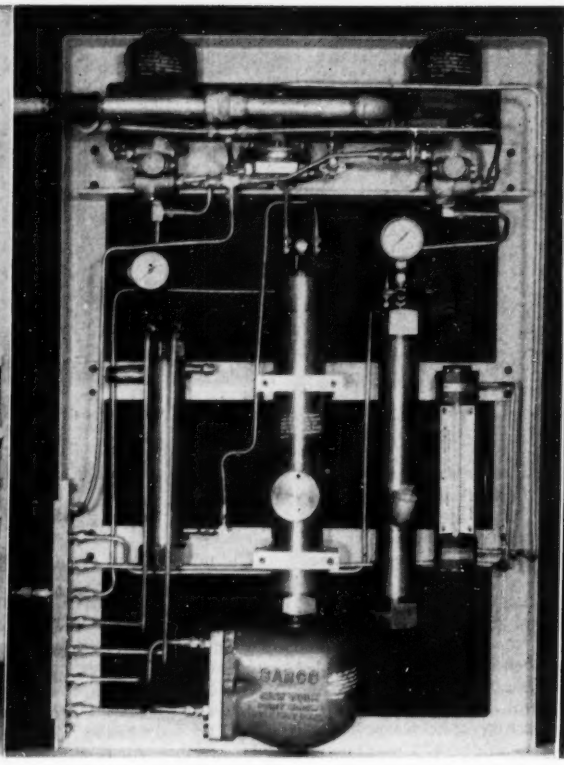

Fig. 2. Typical sampling system for analyzer.

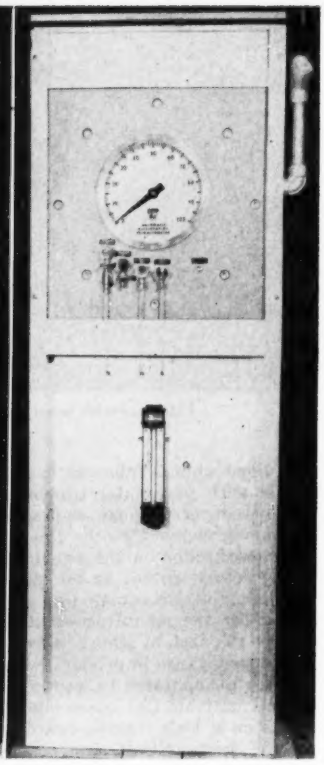

Fig. 3. Phillips automatic differential refractometer.

Continuous Control of Plant Stream by

INFRARED ANALYZER

Important factors in the application of infrared analyzers for continuous monitoring and control of a plant stream include (1) the economic effects of inadequate composition control, (2) sampling points, (3) automatic control factors, (4) methods of sample presentation, and (5) presentation of the analysis to operating personnel.

By D. E. BERGER
Phillips Petroleum Co.

PETROLEUM-refining, petrochemical, and natural-gasoline-separation industries perform large-scale continuous processing of organic liquids and gases, and hence constitute the largest field of application for on-stream analyzers.

Materials must be produced to certain specifications. All process variables which are measured and controlled are a means to that end, but the end itself is composition. Chemical and physical laboratory analyses are used most frequently for composition information. By sampling at many points within the process and at various intervals, data for continuous plant control and periodic material balance evaluation is obtained.

Presented at the Eighth Annual Symposium on Instrumentation in the Process Industries, Texas A & M College, College Station, Texas, January 1953.

Continuous control of process variables (to give steady operations) combined with frequent laboratory tests often is sufficient to give reasonably good plant composition control. However, as laboratory tests are involved and time consuming, the lag between the time of sampling and the analysis report may become excessive and operations may wander widely from the optimum-composition control point. Also, as we strive for a more precise control of composition we find that our present control measurements, such as temperature and pressure, even if made to the required degree of accuracy, are non-specific measurements and therefore may become ambiguous if other components are present or if other process variables influence the control correlation to an undue extent.

In general, we have two types of processes—reactions and separations. In the catalytic dehydrogenation of butylenes to produce butadiene, for example, the inter-relationship of temperature, pressure, space velocity, catalyst activity and other variables must be known to bring about a specified conversion at an acceptable efficiency. Usually, as catalyst activity decreases because of aging, compensation for loss of conversion is obtained by raising reaction temperature. If the process is cyclic, a noticeable decrease of conversion takes place during the cycle. These effects are determined at present by complete laboratory fractional and infrared analysis of samples which represent both the long-term and short-term catalyst decline. From this, it can be seen that correction for loss of conversion can be made only in a stepwise fashion following the analysis report. It is thought that operation at constant conversion level is highly desirable, but it is difficult to obtain even by use of cam-operated temperature control.

Underconversion and overconversion should be avoided. Underconversion is loss of production capacity and makes product separations more difficult; overconversion results in lower efficiency and leads to a shorter catalyst life. The correlation of one or several components in the cracked gas with conversion can be used to follow and control conversion, and to make rapid correction for the catalyst decline. To do this, an infrared analyzer or another specific composition analyzer can be used to report, for example, the butadiene content of the cracked gas continuously, and an override control of reaction temperature may be made either by the operator or automatically. In this way conversion control may be achieved. In such a problem, temperature measurement and control is not sufficient because catalyst activity and decline also must be taken into account.

The separation of isobutane from normal butane by fractionation presents similar problems. The coexisting liquid and vapor phases, pressure, temperature, and composition are interrelated. If pressure is held constant, composition and temperature are directly related. If only two components are present, composition may be found by interpolation between the boiling points of the pure components at the fixed pressure. For example, at 100 psia, isobutane boils at 122.5 F. and normal butane boils at 145.5 F. Therefore, a 50-50 mixture will boil at 134 F. The analytical sensitivity then is such that a change of one degree F. is equivalent to about 4 percent change in composition. Many columns are satisfactorily operated on this correlation. However, if a third or fourth component is present at the temperature-measuring point the correlation is changed and the interpretation becomes ambiguous. This simply means that in a binary system, a sufficient number of equations is available for the calculation of composition from temperature.

However, with additional components present, more equations are needed. These can be obtained only by composition analysis, by measurement of other physical properties not necessarily specific, or by assumption of fixed concentrations of the additional components. In a deisobutanizing fractionator, propane and isopentane are present in the feed stream in varying amounts and thereby detract from the accuracy of the binary control correlation. A change in concentration of one-percent propane at the temperature-measuring point changes the temperature about 3 degrees F., which is equivalent to about 12-percent change in isobutane concentration. Again, composition determination by infrared analyzer offers a specific method of control. By analyzing for either isobutane or normal butane at a certain point in the column, and by using the analyzer to actuate the column control system to maintain the concentration constant at that point, the operation can be held at steady-state conditions.

Economic Considerations

An economic analysis of an analyzer-control installation is difficult because statistical analyses of operations with and without the analyzer must be made and compared. Also, because some time necessarily passes between these two selected periods, the plant conditions—compositions, throughputs, and energy inputs—usually change sufficiently to cast doubts on the accuracy of comparison. A number of analyzers installed in Phillips' plants are estimated to be returning from several thousand to several hundred thousand dollars per year. The instrument payout times then range from a year down to a few days.

To evaluate the possibilities of analyzer control of the separation of isobutane from normal butane, a series of calculations were made assuming some realistic conditions. A fifty-plate fractionating column of sufficient diameter to handle the loads imposed by the 5-to-1 reflux-to-feed ratio is to be used to separate a natural-butanes feed containing 25-percent isobutane and 75-percent normal butane. Current practice dictates that nearly complete recovery of isobutane be obtained, so that the normal-butane kettle-product is of high purity and the isobutane overhead product of lesser purity.

To produce a kettle product averaging 2.35-percent isobutane, it is assumed that a 1.4-percent isobutane stream will be produced for one period, then a 3.3 percent isobutane stream produced for an equal period. This kettle product, when blended, would average 2.35-percent isobutane. The two overhead products, corresponding to the two kettle products when blended, will average 91.5-percent isobutane (respectively 87.4 and 96.3 percent isobutane.). Another calculation shows that with steady operations producing a kettle product of the previous-averaged composition, the corresponding overhead-product composition will be 95.0-percent isobutane, which is 3.5 percent higher in isobutane than the previous-averaged overhead product. Another calculation shows that by lowering the reflux-to-feed ratio to 4.7 to 1, the same products could be made as in the averaged case with the expenditure of 5.8 percent less energy.

Much more important is the fact that the capacity of the fractionator can be increased this 5.8 percent while producing the same purity products at the same energy cost. This increase of several percent may seem small, but when multiplied by the usual several hundred thousand gallons per day feed to natural deisobutanizers it becomes a sizeable figure. Also, when the investment in equipment per unit of capacity is considered, the value of a relatively inexpensive increase in capacity becomes evident. There will be comments for and against this method of evaluation, but it is evident that when the equipment is already loaded to capacity, and when high recoveries and purities of products are desired, then the benefits derived from precise control may be taken in the form of purity increase, recovery increase, energy-requirement decrease, capacity increase, or some combination of these. Where products of higher purity than those used in the example are desired, the benefits can be greater than those calculated. It has been shown by several installations that the infrared analyzer can be used to obtain steady type of control of butane-splitter columns; the continuous analytical instrument serves as a guide for the operator or, better yet, it is used in an automatic control system. These same factors and results apply to more complex separation systems. The possibilities may justify the purchase and application of an analyzer.

Sample Points

The selection of points for sampling an isobutane—normal-butane fractionating system for infrared analysis requires several decisions. The first is whether the instrument is to be used for (1) continuous data for material balance and production purposes, (2) as a guide for operator control, or (3) as a control device. If material balance and production data are desired, then the final-product streams from the fractionation system must be sampled and analyzed.

In one of Phillips' refineries the operation of a deisobutanizer is indicated by analyses of an isobutane stream and a normal-butane stream, each of which has been further fractionated upon leaving the deisobutanizer. This method results in a moderate time lag but is adequate for monitoring purposes. In another of Phillips' refineries two deisobutanizers in parallel operation are "balanced" by the operator by maintaining the same isobutane concentration in the overhead product of each column. This would be a good control possibility except for the fact that this analyzer's duty is five-stream cyclic analysis. A third analysis per-

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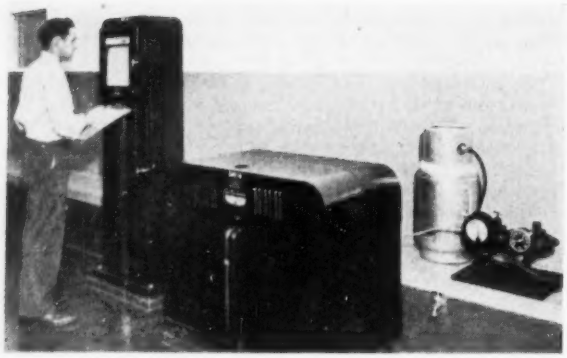

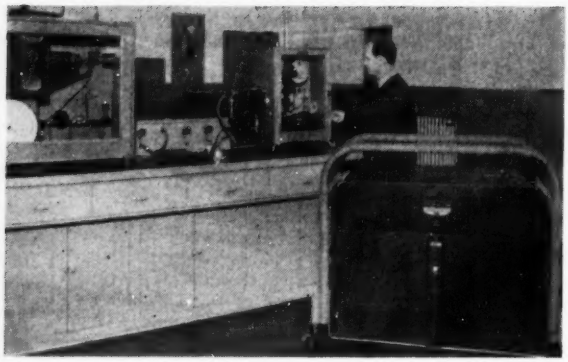

Fig. 1. The Cutler-Hammer recording calorimeter, showing tank unit and recorder unit. A lift and carrier for the tank unit is shown at the right.

The Cutler-Hammer

RECORDING CALORIMETER

The modern air-flow calorimeter is a basic industrial test and operational instrument. This article presents the principle, operation, installation, calibration techniques, and maintenance factors of the Cutler-Hammer recording calorimeter.

By
BLAKE O. COSSEY
Southern California Gas Co.

DURING the first years of the gas industry, gas was used principally for lighting purposes. Thus values obtained by use of the photometer, an instrument for determining the candle-power of the gas, were considered sufficient for gas quality indication. As time went on it became obvious that some method of determining the heating value of gas was necessary.

In 1812 Count Rumford, the originator of the mechanical theory of heat, having proved by experiments the equivalence of heat and work, succeeded in producing an instrument, or calorimeter, for measuring the amount of heat of combustion of substances. This calorimeter may be described as having a receptacle containing a given quantity of water, through which passes a serpentine tube. The products of combustion pass through this tube and transmit to the water the heat of combustion that was generated; the fixed number of degrees rise in temperature of the water serving as a basis of the calculations. This calorimeter embodied the general principles that we now recognize as fundamental, and upon which the design of the modern water-flow and air-flow calorimeters is based. The air-flow recording calorimeter in most general use is the Cutler-Hammer recording calorimeter.

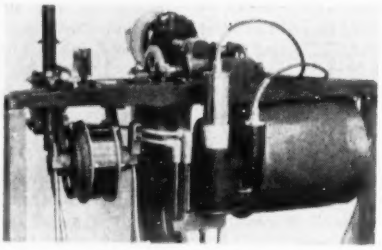

Fig. 2. Metering unit.

Principle of Operation

The recording calorimeter (Fig. 1) consists of two separate units—a tank unit or calorimeter proper, where the heating value of a gas is measured, and a recorder unit which translates the heat measurements into British thermal units* and records them.

The heating value of the test gas is determined by imparting all the heat obtained from the combustion of the test gas to a stream of air and measuring the rise in temperature of the air. The streams of test gas and heat-absorbing air are maintained in fixed proportion to each other by metering devices geared together and motor driven. Consequently the temperature rise produced in the heat-absorbing air is directly proportional to the heating value of the test gas without regard to the actual rate of gas burning. This temperature rise is translated into Btu per standard cubic foot and recorded graphically.

Detailed Description

The test gas is piped to the calorimeter tank unit (Figs. 2 and 3) where it passes through a small pressure-reducing orifice, the combination overflow-drip connector, and the inlet gas connector into the gas-meter inlet riser. A second passage connects the inlet head of the gas meter to an open burner of sufficient area to prevent any pressure building up in the inlet head at the gas rate fixed by the orifice in the sample line. The inlet orifice is selected to deliver gas at a rate corresponding to approximately 1200 Btu per hour, approximately 15 percent of which passes through the gas meter into the main burner. The continuous flow of gas through the meter head not only speeds up the sample to the metering passages but also increases the rate at which the water in the gas meter becomes saturated with the changing sample of gas.

*Btu—British Thermal Unit is the quantity of heat required to raise the temperature of one avoirdupois pound of pure water one degree Fahrenheit. with the heat capacity of water taken as 1 at 59 deg. F.

Presented at the Los Angeles Harbor Junior College "Instrument Maintenance Short Course," Nov. 14, 1951.

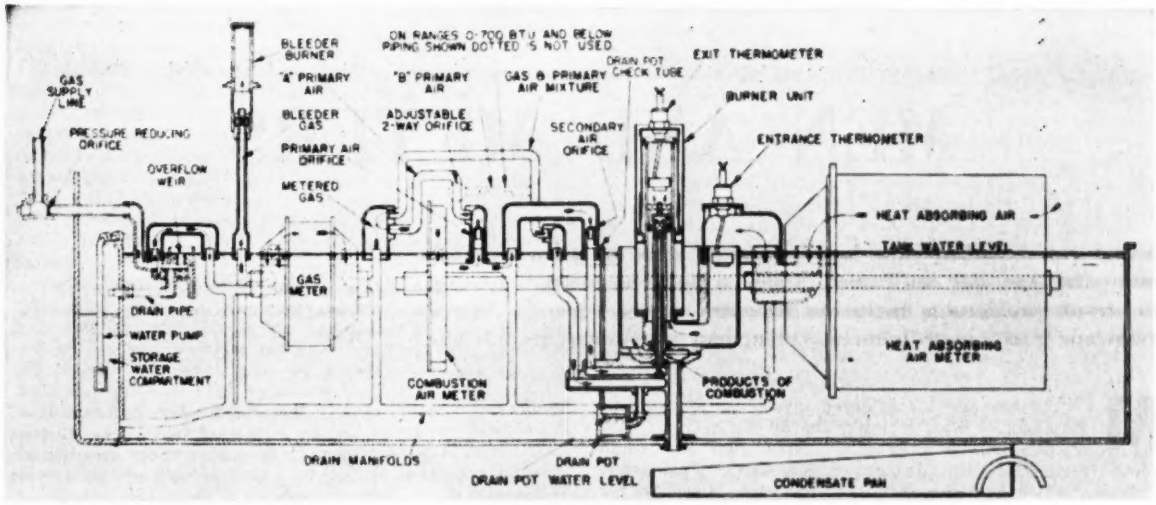

Fig. 3. Schematic of tank unit.

The three pumps for heat-absorbing air, combustion air, and test gas are driven by a motor through suitable reduction gearing. They are all mounted on the cast base which serves to keep all the pumps in fixed alignment. The gas pump and combustion-air pump each consists of a series of tubular passages, operating in the same manner as an ordinary water-sealed gas meter. The heat-absorbing air pump is a cast-brass water-sealed screw conveyor operating in similar manner. The three pumps are adjusted and calibrated to give a standard discharge but may be geared in any desired ratio for different classes of service. The two air pumps are arranged to take their air supply direct from the air above the water in the calorimeter tank. The water in the tank serves to supply the common water seal for all pumps. On the tank are arranged leveling points and the overflow weir. By means of these leveling points the whole system can be adjusted parallel to the surface of the water seal in the tank.

The water in the tank is always maintained at such a height that it will constantly run over the overflow weir. This circulation is automatically maintained by the pump bringing up water from the auxiliary supply tank. The flow of water over the overflow weir also provides a seal for the drip pot in the combination overflow-drip connector.

The sample of gas is burned in a closed-type burner which is entirely separate from the stream of heat-absorbing air. The incoming and outgoing temperatures of this heat-absorbing air are measured by a pair of electrical resistance thermometers in a Wheatstone-bridge automatic recorder. The rise in temperature is a measure of the heating value of the gas interpreted in terms of total Btu per standard cubic foot*.

Fig. 4. Hydrogen generator.

The use of air as a heat-absorbing medium presents particular advantages for a recording calorimeter system. Air follows the same physical laws as to expansion or contraction with varying temperatures and barometric pressure as the gas to be tested. Its power for absorption of water vapor is also the same as the gas. Consequently the accurate proportioning of the streams of heat-absorbing air and test gas is easily obtained by ordinary volumetric displacement means where the two gases are supplied to the measuring devices at atmospheric pressure and at the temperature of the common water seal. This seal also serves to saturate both streams at the same temperature. Two factors, the dilution of the gas with water vapor and the variation in specific heat of saturated air, would tend to introduce small errors into this method, but as both errors are a function of temperature, correction for them is applied by using wire for resistance thermometers which has a characteristic, over fairly wide temperature ranges, that is the same as these combined errors and thus compensates for errors from these sources.

At the outlet of the combustion-air meter (Fig. 3) the air is split into primary and secondary air. The primary air is mixed with the gas and conducted to the burner where the secondary air is admitted. The products of combustion pass out of the calorimeter after having given up their heat through the interchanging tube. The heat-absorbing passages are entirely separate from the products-of-combustion passages. The direction of flow of the combustion products is counter to that of the stream of heat-absorbing air, so that the products of combustion are cooled to within a few degrees Fahrenheit of the temperature of the entering cold air. The combustion mixture enters the burner saturated with water vapor and at the temperature of the cold air (because of the common water seal) and leaves the calorimeter within a few degrees of the same temperature. It is evident, therefore, that essentially all the heat of combustion including the latent heat of vaporization of the water formed in combustion is given up to the heat-absorbing air. The possible errors do not exceed one-tenth percent per degree Fahrenheit difference between the ingoing combustible and outgoing products. To cut down heat losses, a polished double-walled tube is provided around the burner jacket, which is in turn jacketed with the heated air.

The two thermometers consist of selected nickel wire with about 50-ohm resistance, carefully calibrated and adjusted to a standard characteristic. With proper Wheatstone-bridge equipment, temperatures may be measured to within a few hundredths of a degree Fahrenheit.

Continued on page 898

*The Standard cubic foot of gas as defined by the Pacific Coast Gas Association in their publication "Fuel Gas Calorimetry, Water-Flow Method" is as follows: The quantity of gas which, when at a temperature of 60 deg. F., under a pressure equivalent to that exerted by a column of mercury 30 inches high (the mercury to be at a temperature of 32 deg. F.) and saturated with water vapor, occupies a volume of one cubic foot.

MEN AND METERS

A general superintendant of a large processing plant becomes intimately familiar with the human factors in instrumentation, which present problems to instrument designers, process instrument engineers, instrument foremen, and instrument technicians.

By T. A. MANGELSDORF
Port Arthur Works, The Texas Co.

MANY years ago I considered myself an Instrument Engineer. I was, I think, one of the original subscribers to the magazine *Instruments* and could quote freely from the Bureau of Standards' *Pyrometric Practice*, which is still a standard reference. However, the field of instrumentation has become so complex that I can no longer qualify as an expert. Hence I wish only to relate some observations regarding human factors affecting and affected by instrumentation and Instrument Engineers.

Labor Requirements of Industry

One important consideration in the establishment of any new undertaking is the availability of manpower required to operate the new facility. The greater the labor requirement, the more important this factor becomes as compared with other considerations. Generally speaking, the Southwest is not densely populated and has not had large labor surpluses. It would appear, therefore, that lack of manpower would have been a decided deterrent to the establishment of industry in the Southwest—had not instrumentation materially reduced manpower requirements. Instruments have permitted the development of industry in our relatively sparsely populated Southwest. That is a great accomplishment.

Human Problems

It is becoming necessary to give more attention to the human problems in instrumentation. These problems include not only "human engineering"—which has been defined as "the study of the human factor in machine design"—but also the relationship of one human to another.

The study of "human engineering" was given considerable impetus when it was found during World War II that many of the weapons, and the instruments supplied to control the weapons, could not be operated satisfactorily by the personnel available.

The instrument designer should keep in mind at all times that his designs will be installed, maintained, and used by humans. There are many factors related to human reactions which will determine, or strongly influence, the success or failure of a particular design. No doubt most of you have had experience with instrument installations which did not function properly because the control valve was installed in a reversed position in the line, or because of some other equally simple mistake in hookup. What may seem perfectly obvious to the instrument designer may be not at all obvious to the less specialized intelligence of the installation crew.

In regard to maintenance, the Design Engineer must keep in mind the limitations of those who are expected to maintain the instruments which he designs. Instruments have been abandoned because their maintenance, although not difficult, required skill and training beyond that required for any other instrument in the plant. I do not imply that instrument designers should never develop instruments, the maintenance of which requires skill and training beyond that currently required. We would not have electronic instruments, or any instruments for that matter, if instrument designers had so restricted themselves. But an instrument is handicapped if its maintenance requires an inordinate amount of skill or training. Such a simple thing as the size of the ink reservoir on a recording instrument, and the ease of filling may have a strong influence on its acceptance.

Problems of the Process Instrument Engineer

The Process Instrument Engineer who is responsible for fitting the instrumentation to the process has all of the problems with respect to human reactions that the Design Engineer has and, in addition, the important question of how far the instrumentation should be carried. There are certain jobs that can be done better by instruments—others had best be left to humans. Generally speaking, the purposes of instrumentation are to save manpower, perform functions which cannot be performed by humans, centralize control, and provide safeguards. In general, instruments are a necessity for *measurement*. Temperature, pressure, and flow measurements are almost impossible without instruments. In the realm of control, however, there is usually a choice between instruments and humans, and the Instrument Engineer has the responsibility of coordinating and integrating the capabilities and functions of men and instruments. Sometimes the decision is wholly economic. If the saving in labor is sufficient to justify the investment in instruments, instruments are indicated as the choice. However, instruments may not be the proper choice even though simple economics would so indicate, and instruments sometimes should be installed because of certain human factors, even though the superficial economics indicate no savings.

One of the simplest control instruments is a pressure relief valve, and its selection for the protection of vessels can be justified on the basis of simple economics in saving labor. It would be possible to install a pressure gage and a hand-operated valve with a man stationed there to watch the pressure gage and open the valve if the pressure became too high. Would we make such an installation even with zero labor cost? The answer is no—because of the human factors involved. No man could sit or stand all day watching a pressure gage and maintain his alertness. Therefore, where no intelligence is required the instrument is more reliable. Another point is that man unconsciously revolts against being made a machine. The average human would rebel against such an assignment.

Sometimes instruments can be justified, even though there is no labor saving involved, by making the job less tiring and thereby making the operator more alert. On the other hand, instrumentation can make the job too easy, and as a result the operator becomes careless. The Instrument Engineer must predict and evaluate all of the human reactions which are involved.

It is possible to over-centralize instruments. Even with extensive instrumentation, there is a minimum below which the number of human operators should not be reduced because of the problems which cannot be handled by instru-

Presented at the Eighth Annual Symposium on Instrumentation in the Process Industries, Texas A & M College, College Station, Texas, January 1953.

ments during startups, shutdowns and emergencies. Apart from the cost of installing more instruments than are required, isn't it better to have some of the operators circulating around the unit taking readings, observing, and making adjustments where needed than to have all of them grouped around a central control board which, except in case of emergencies, does all of the work for them? Which operator do you think would be more alert? Which do you think would leave the plant at the end of his shift with the greater feeling of accomplishment? Which do you think would be better prepared to handle emergencies when they occur?

Instruments can handle only a limited number of conditions, whereas the human can perceive many conditions at a glance, and can decide on methods of correction. I recall an incident where a hot spot occurred on a vessel on the seventh or eighth floor of a catalytic cracking unit. But, because certain functions which could have been instrumented were deliberately left for human control, the operator was required to visit the upper levels of the unit periodically, and during the course of one of his visits discovered the hot spot and took corrective steps in time to prevent a serious rupture.

In an address before this group about five years ago, Dr. C. M. Blair of Carbon and Carbide Chemicals Corporation made the point that "good enough is best," pointing out that it was an economic waste to install instrumentation having greater accuracy or sensitivity than was required to do the job at hand. I agree with him, but I would also say "enough is best." Put in enough instrumentation to do what is required, but remember that human operators are also needed. "Enough is best."

I want to mention just briefly the tendency of operators to rely too much on their instruments. The situation now is the reverse of what it was in the early days of instrumentation. At one time, one of the Instrument Engineer's main problems was to "sell" instrumentation to the operating people. The operators now have been sold so completely that they sometimes forget that instruments are fallible. The alert Instrument Engineer recognizes this and will so engineer his installation that the human operator will be required to check periodically those locations where false readings could create hazardous conditions.

Problems of the Instrument Foreman

The Instrument Foreman is concerned with many of the problems of human relations and human reactions which concern the instrument designer and Process Instrument Engineer and, in addition, has the myriad human problems associated with being a supervisor of men. There are a few fundamentals of good supervision which, if practiced consistently, will greatly ease the Instrument Foreman's task. His success is dependent not as much upon his own individual accomplishments as upon the accomplishments of the entire group which he supervises. His major efforts, therefore, should be directed toward building and maintaining an effective, smooth running organization.

The first step is in the selection of competent personnel. Even with rigid seniority regulations, it is seldom necessary to retain an individual who fails to qualify after a reasonable period of trial. The next step is to see that the personnel are thoroughly trained. In this connection, the Industrial Instrument Training Course Outline sponsored by the Instrument Society of America should be of assistance. Throughout the training period the progress of the individuals should be carefully checked, and those found to be unsuited for the work should be disqualified. Having selected and trained the personnel, they must be given adequate tools with which to work—including shop facilities, reference books, test instruments, transportation facilities when required, materials, a system of making materials available, provisions for communicating and cooperating with related crafts and operating personnel, etc.

Perhaps the most important task of a supervisor is to build and maintain the morale of his organization. The most basic precept in human relations is the admonition in the Sermon on the Mount: "Therefore all things whatsoever ye would that men should do to you, do ye even so to them." All men must be treated as individuals. A supervisor has the responsibility for the individual welfare of each man under his supervision, who looks to the supervisor to protect his just interests. Each worker wants to know how he is getting along. Don't hesitate to tell him. Point out ways in which he may improve himself and, by all means, if he is doing superior work let him know that he is. Keep your workers informed about what is going on and why, particularly with respect to any changes or activities that will affect them individually.

General J. Lawton Collins, Chief of Staff of the United States Army, gives the following advice to his officers to help them become better officers: (1) Know your business thoroughly, (2) refuse to compromise on quality, (3) explain the "why" of things to those under you, (4) divide responsibility fully and effectively, and (5) take care of your men.

This advice is just as applicable to a supervisor in industry as it is to a military officer.

Problems of the Instrument Technician

The Instrument Technician, or Instrumentman, also has human-relation problems. He should remember that he is a part of a service organization intended to assist operating personnel. His is an essential function, but he should remember that no instrument in itself ever produced a gallon of gasoline or a pound of chemical. Instruments and Instrumentmen are useful only to the extent that they can aid operations and operating personnel. This requires an understanding of the operations and of the operating problems, and a close degree of coordination and cooperation between operating and instrument-department personnel. The Instrumentman who goes on an operating unit and changes or adjusts instruments without consulting operating personnel is bound to create friction, and may cause serious upsets in the operations. On the other hand, the individual who merely repairs a faulty instrument on request of operating personnel and makes no effort to understand the process and adjust the instrument to the process, or to anticipate troubles and correct them before they occur, is not performing his full functions.

While going around the plant one morning, I mistook an Instrumentman for one of the operators and asked him a number of detailed questions concerning the operations, all of which he answered fully and intelligently. I was surprised later when I found that he was not an operator and made some inquiries about him. The operating personnel were enthusiastic in their praise of this man and made a strong point of the fact that he had taken the trouble to learn the process thoroughly and knew the function of each instrument with relation to the process, so that it was possible for him to adjust the instruments to function as integral parts of the process and not as individual instruments which might be working against each other. He cooperated wholeheartedly with the operators and was as much interested in the production from the unit as they were. He took pride in the part he had in maintaining maximum production. Today that man is a supervisor.

In addition to the human-engineering or human-relations problems which you have with the people who install, maintain, and use instruments, you also have human relations problems with the people for whom you work. It is helpful if we know what characteristics are expected of us by our superiors. Many could be mentioned, but I believe that these are the most important: (1) Knowledge and a willingness to continue to learn. (2) Intelligence and judgment to apply this knowledge. (3) Initiative, industry, and tenacity to get the job done. (4) Ability to cooperate with others. (5) Complete honesty, morally and intellectually.

Finally, we all have human relations problems because we are citizens of the community, of the state, and of the country in which we live. We should try to be good citizens. We have a responsibility to use our abilities in civic and community affairs so that the principles upon which this nation was founded and became great may not be abandoned through our apathy.

Control of Chemical Processes

Matching a proportional controller to a plant requires knowledge of plant characteristics. Installment 6 of this series shows how a disturbance is changed in amplitude and phase in passage through a plant, presents an analyzer for obtaining plant characteristics, and explains the techniques for matching a proportional controller to a plant of known characteristics.

by
A. J. YOUNG*

VI. Matching Proportional Controller To Plant

It has now been shown that good control requires (i) a high deviation-reduction factor, (ii) a short operating period, and (iii) minimum offset.

We have seen that each of these factors is dependent on the proportional control factor (μ) and that to obtain best control it is necessary to use the highest value of μ which is compatible with control-system stability.

In the following analysis it will be shown how the value of μ which can be used depends on the plant characteristics, and what measures can be taken when the value of μ is limited to a magnitude insufficient to give satisfactory control in the plant conditions anticipated.

First it is necessary to examine the effects of attenuation and phase lag suffered by a disturbance as it passes through a plant which is not under automatic control.

Attenuation and Phase Change in Plant

Every plant has time lags which decrease the amplitude of a continuously varying disturbance passing through it, and which also produce a phase lag in that disturbance. Similar conditions apply to each part of the closed-loop control system. Capacities and resistances give rise to transfer lags. It has also been seen that pure distance-velocity lag produces a delay in transmission of a change from one part of a plant to another, but does not decrease the magnitude of the disturbance. Transfer lags, on the other hand, produce both delay and decrease in magnitude of a disturbance passing through the plant.

It is not easy to calculate the lags even in a comparatively simple system such as a temperature-detecting element in a protective pocket. It is much more difficult to calculate the time lags in plant components such as heat exchangers, stills, evaporators and so on, even when the plant is new. In operating conditions, when the effects of dirt films on the surfaces and other unpredictable factors are important, the calculation is virtually impossible. The lag must therefore be determined experimentally, and one method is described.

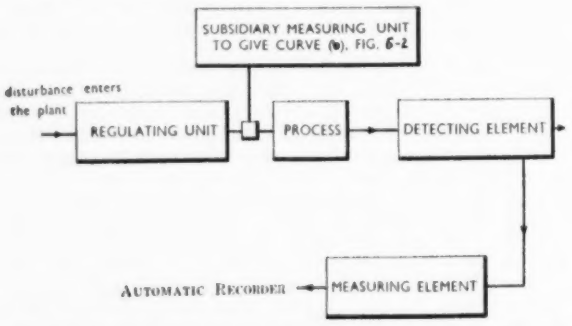

Fig. 6-1. Instruments for measuring disturbance at input and output of plant. Subsidiary measuring unit gives curve (b) of Fig. 6-2; measuring element gives curve (a) of Fig. 6-2.

The effect of time lags in a plant could be examined by recording the magnitude of a disturbance at two points simultaneously. For example, in Fig. 6-1 a plant is shown provided with a subsidiary detecting element near the regulating unit and a second element some distance downstream of the regulating unit. If a disturbance is imposed on the plant by varying the psi. to the regulating unit, the two records obtained might give the curves of Fig. 6-2. For ease of interpretation a continuous disturbance varying sinoidally with time has been taken. The plant, it should be noted, is not controlled automatically or manually while the records of the disturbance are being taken.

Comparison of the two records in Fig. 6-2 shows that in its passage through the plant the disturbance is decreased in amplitude in the ratio a_1/a_2. This ratio is the "attenuation" (A) suffered by the disturbance due to its passage through the capacities and resistances of the plant. It is also evident that the outcoming disturbance is about 180 degrees out of phase with the incoming disturbance; that is, it has suffered a phase lag of approximately 180 degrees.

If the period of the disturbance is reduced, the attenuation and the phase lag are both increased, but not in general in the same ratio.

If the experiment is repeated for disturbances of various periods, plots can be made to show the way in which attenuation and phase lag depend on the period of the disturbance. Examples are shown in Figs. 6-3 and 6-4, which can be more conveniently plotted on a single diagram, known as the "frequency response" diagram, such as Fig. 6-5. Note that the phase lag is plotted on a linear scale whereas the period and attenuation are plotted on a log scale.

The information given about the plant characteristics in Fig. 6-5 is essential for logical design of a system to control the plant. A method of obtaining the information for plotting the frequency-response diagram is therefore described.

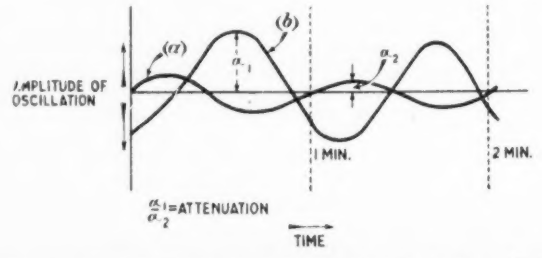

Fig. 6-2. Curves illustrating attenuation and phase lag in plant. Curve (b) is sinoidal disturbance imposed on regulator at input to plant; curve (a) is record of detecting element at "end" of plant.

*Technical Department, Imperial Chemical Industries, Ltd., London. This series of articles originally appeared in the *Industrial Chemist*, England.

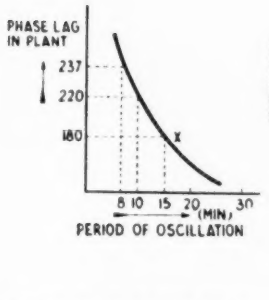

Fig. 6-3. Curve of phase lag in plant vs. period of oscillation.

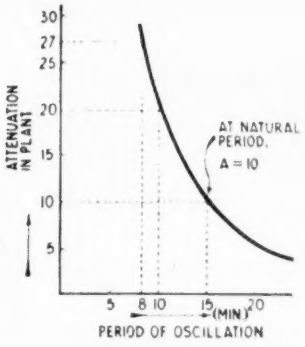

Fig. 6-4. Curve of attenuation in plant vs. period of oscillation.

An Analyzer For Obtaining Plant Characteristics

Assume that the plant is controlled by a pneumatically operated valve. All we have to do is to apply a sinoidal variation of air pressure to the valve, record this varying pressure, and record (on the same chart) the resulting variation of signal from a detecting element installed at a suitable location in the plant. The plant is not controlled during this experiment.

A piece of equipment for doing this has been described in the literature.* It has provision for varying the period, amplitude, and mean value of the sinoidal air pressure applied to the regulating unit. It utilizes a linear roll chart for convenience in comparing the two curves, which correspond to curves (a) and (b) in Fig. 6-2. The design of this analyzer (Fig. 6-6) is shown in Fig. 6-7. Fig. 6-8 shows the arrangement of equipment and plant for carrying out an analysis. It is convenient to feed the signal from whatever element is used to a pneumatic proportional controller and to apply the air pressure from this controller to the analyzer.

The attenuation and phase lag produced by the plant at the periods used in the analysis are easily determined from the two records on the analyzer chart, and a frequency-response diagram, such as in Fig. 6-5, can be made from the records.

* A. R. Aikman, "A Portable Instrument for Control Analysis," *Instrument Practice*, Vol. 5, page 393, 1951.

J. Halsall, "A Portable Instrument for Control Analysis—the Electrical Equipment," *Instrument Practice*, Vol. 5, page 793, 1951.

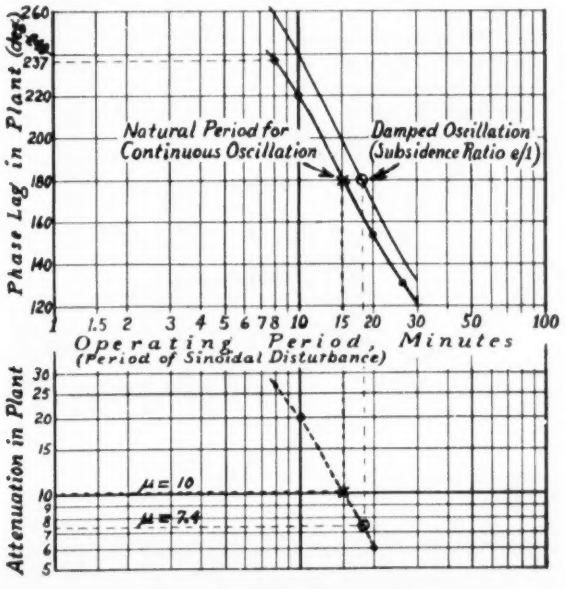

Fig. 6-5. Frequency-response diagram.

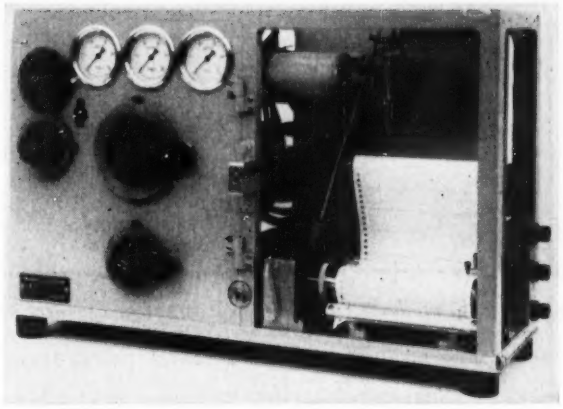

Fig. 6-6. Analyzer for obtaining plant characteristics.

Examination of Conditions for Good Control

Before use can be made of the data obtained on plant characteristics, it is necessary to know how these determine the controller characteristics required to give optimum quality of control.

It has already been seen that the proportional control factor (μ) must be made as large as possible without introducing instability. Let us now examine the conditions which determine this value of μ in a proportional-action controller.

Suppose a step disturbance occurs in the supply to a plant under proportional control. A narrow proportional band will tend to cause oscillations to be set up; as the proportional band is narrowed, the oscillations become less and less damped, as shown in Fig. 5-3 of the preceding chapter.

Let us follow in theory the same procedure as is normally followed in practice in setting up a new proportional controller on the plant—that is, we shall find the value of μ which will cause the plant to "hunt" after a sudden disturbance, and then find how much μ must be reduced in order to give a damped oscillatory curve.

It may reasonably be asked why we should take the trouble to do this when it is a short process to carry out by trial and error on the plant. The reason is that it is only by a knowledge of the fundamental principles of control that results can be predicted, and that a logical approach can be made to difficult problems. Perhaps it is even more important that an engineer responsible for plant design may be persuaded that it is worth while pursuing the matter a little further, with the object of *designing* the plant for good control. As more analyses are made of operating plants, more quantitative information will become available for the use of plant design engineers who are ready to apply it to new plant design.

In order to study the behavior of the system, assume that a sudden disturbance in the form of a step increase in

Continued on page 904

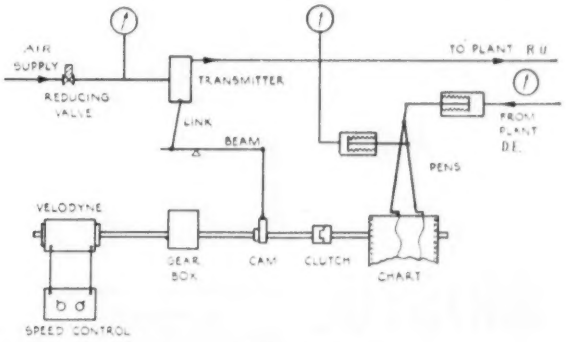

Fig. 6-7. Diagram of analyzer.

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CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P.M. Hotel Shoreland, Chicago, Ill.

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P. M.

CINCINNATI
E. J. Geiser, 3666 Hubble Rd., Cincinnati 24, Ohio Tel. Ja. 5618.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P. M., Engineering Soc. of Cinn.

CLEVELAND
M. M. McMillen, Thompson Products, 2196 Clarkwood Ave., Cleveland, Ohio
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191, Ext. 247.
Third Thursday, Meeting at 8:00 P. M. Battelle

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P. M.

DENVER
Karl F. Kent, Jr., 5030 Umatilla, Denver 11, Colo. No regularly scheduled meetings. Univ. of Denver, Science Bldg.—Campus

DETROIT
R. A. Hoxie, Basic Service Corp., 14016 Woodrow Wilson, Detroit 6, Mich.. Tel: TO-88043
Third Wednesday, Meeting 8:00 P. M.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P. M., Siena College, Loudonville, N. Y.

FOX RIVER VALLEY
John R. Redgrave, 109 S. Appleton St., Appleton, Wis.
First Tuesday, 8:00 P. M.

HOUSTON
A. Costa, 6209 Edloe St., P.O. Box 6614, Houston, Texas.
Last Monday 8 P.M. U. of Houston Library

KALAMAZOO VALLEY
Jack M. Fettig, 433 Thomas St., S.E. Grand Rapids, Michigan.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M. Meeting at Red Arrow Legion Post.

KANSAS CITY
Donald D. Baker, 5823 Mission Rd., Mission, Kansas
First Tuesday, Meeting at 7:30 P. M., U. of Kansas City, Science Bldg., Rm. 106.

LAKE CHARLES
A. T. Clinger, Columbia Southern Chemical Corp., P. O. Box 900, Lake Charles, La. Tel. 6-7522
First Wednesday after last Monday, Dinner and regular meetings at McNeese State

LOUISVILLE
O. Vern Spousta, 2000 S. Brook St., Louisville, Ky.
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 1950 Sherbrooke St., West, Montreal, Tel. G1 5711
Last Monday of month, Meeting 8:00 P. M.

MUSCLE SHOALS
Atherton Hastings, TVA, Div. of Chemical Engineering, Wilson Dam, Alabama. Tel: Sheffield 3160, Ext. 6238
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.

NIAGARA FRONTIER
Duran L. Hagler, 214 E. Delavan Ave., Buffalo, N. Y., Tel: ELmwood 1258
Fourth Monday, Dinner at 6:00 P.M. Meeting at 8:00 P. M., N.Y.S. Technical Institute.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHERN CALIFORNIA
Robert L. Norman, 351 42 St., Richmond, Calif. Tel: BE 2-0901
Third Monday, Meeting 8:00 P M.

NORTHERN INDIANA
J. B. Beckman, 7145 Wicker Ave., Hammond, Ind. Second Tuesday, Meeting at 8:00 P. M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
Thomas M. Gayle, 117 W. Vanderbilt Drive, Oak Ridge, Tenn. Tel: 2-1516.
First Wednesday Meeting at 7:30 P. M.

OGLETHORPE
J. R. Upson, 213 54th Street, Savannah, Georgia
Second Friday, 8 P. M. Reddy Kilowatt Room, Savannah Electric and Power Company.

PADUCAH
J. B. Russell, Carbide & Carbon Chemicals P. O. Box 748, Paducah, Ky. Tel: 5-6311—Ext. 403
Second Tuesday Dinner at 6:30 P. M. Meeting 8 P. M.

PANHANDLE
George W. Leggett, 1600 Western Ave., Amarillo, Texas.
Third Tuesday, Dinner at 7:30 P.M. Phillips Grade School Cafeteria, Phillips, Texas

PERMIAN BASIN
Jack M. Ray, P.O. Box 1386, Odessa, Texas
Second Tuesday, Dinner at 8 P.M. Tel: 2-2813

PHILADELPHIA
A. S. Chatfield, c/o American Meter Company, 1513 Race St., Philadelphia 2, Pa.
Third Wednesday, Meeting at 8:00 P.M., Bellevue-Stratford Hotel.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa. MA 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel

PRESQUE ISLE
Edwin P. Schuwerk, 445½ Halley St., L. P., Erie, Pa. Tel: 2-2349
Fourth Tuesday, Meeting at 8:00 P. M.

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash. Tel: 5-8692
Second Wednesday, Meeting at 7:30 P. M.

ROCHESTER
R. C. Schwarz, Jr., 1201 Granite Bldg., Rochester 10, New York. Tel: Hamilton 1468
Fourth Tuesday, Meeting 8 P.M. U. of R., Bausch & Lomb Physics Lecture Room 109.

SABINE-NECHES
R. A. Block, 2301 Avenue "G", Nederland, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Third Monday, 8:00 P.M., Y.M.—Y.W.C.A.

SAVANNAH RIVER
F. P. Ledford, Jr., 907 Royalette St. N. Augusta, S. C., Tel: 5-4626
Second Wednesday, Dinner at 7:30 P.M. North Augusta Legion Post.

SEATTLE
Frank S. Melder, 2439 76th N.E. Bellevue, Washington, Second Friday.

SOUTH TEXAS
Homer C. Givens, P.O. Box 637, Falfurriar, Texas. Tel: 202
First Thursday, Engineers Club

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P. M.

TOLEDO
Howard R. Daily, 2025 Scottwood Ave., Toledo, Ohio.
Third Tuesday, Meeting at 8.00 P. M.

TORONTO
John W. Huether, 311 Sutherland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Fourth Thursday, Meeting at 8:00 P. M.

TENNESSEE
James L. Williams, 1617 Carolina Ave., Kingsport, Tenn. Tel: 2079 L.

TULLAHOMA
B. A. Artz, RFD #2, Tullahoma, Tenn.

TULSA
A. J. Sesock, 845 South East Ave., Tulsa, Okla., Tel: 8-1112
First Monday, Meeting at 7:30 P.M.

TWIN CITIES
John L. Schmidt, 1879 University Ave., St. Paul 4, Minn., Tel: DR 0064
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P. M.

WASHINGTON
Edward C. Lloyd, 2105 Spencer Road, Silver Spring, Md. Tel: SH. 9340.
Third Monday, Meeting at 8:00 P. M.

WAYNE COUNTY
Clarence Ellison, 2443 15th St., Wyandotte, Michigan. Tel: Avenue 2-4178.
Third Monday, Meeting at 8:00 P. M.

WICHITA
J. W. Rieg, c/o Koch Engineering Co., Inc., 321 W. Douglas Ave., Wichita 2, Kansas
Third Thursday, 8 P. M. Scientific Bldg.

WILMINGTON
W. C. Ruglass, 900 A West 8th Street, Wilmington, Delaware
Second Tuesday, 8:00 P. M. Harlan School.

R. T. Sheen Presents Charters

ISA Vice President, R. T. Sheen presented two charters during May. Flying around the country in his private plane, Mr. Sheen presented charters to the Oglethorpe Section, located in Savannah, Georgia, and to the Wichita Section, of Wichita, Kansas.

M. A. Dimmick

It is with deep regret that the Northern California Section informed the National Office of the death of one of their members, M. A. Dimmick. Mr. Dimmick died of a heart attack on February 19, 1953. He served as Secretary-Treasurer of the Northern California Section from 1949-1950, and he was employed at the Mare Island Naval Yard, San Francisco.

ISA NEWS

Report of Operations Division

J. M. RIBBLE

The Finance, Meetings and Exhibits, and Publications Committees all come under the supervision of Vice President J. M. Ribble of the Operations Division. Given below is a progress report by Mr. Ribble on these three very important committees of the Instrument Society of America.

Finance Committee

This committee under the chairmanship of George R. Feeley has done an excellent piece of work, strengthening finances of the Society substantially. A meeting of the Finance Committee will be held in the National Office in Pittsburgh on May 27 and 28th. The budget will be prepared and submitted to the Executive Board on June 11 for consideration. The final budget will be presented at the National Council meeting in Chicago during the Eighth National Instrument Conference and Exhibit.

Publications Committee

Charles W. Covey, Chairman of the Publications Committee has done an outstanding job to simply the preparation of technical papers to be presented before ISA meetings. Nine publication forms have been completed to expedite the flow of Technical papers and to aid authors in preparing their papers for the National Conference. "A Guide for the Preparation and Presentation of an ISA Paper" informs authors of the necessary requirements in planning a good paper for presentation and standard abbreviations used by the Instrument Society of America —as well as chart and photo measurements.

For the first time since the inception of ISA, the Proceedings have been published within six months after the Conference. The Proceedings of the Seventh National Instrument Conference and Exhibit, consisting of 366 pages are now available to members and nonmembers of ISA.

Two Recommended Practices, RP1.1 and RP2.1, have been edited for final publication. Final editions will be sent to all members in a very short time.

Meetings and Exhibits Committee

Through his experienced efforts, Ed. Grace has done an excellent job of coordinating the functions of the Exhibit, Chicago Host Committee and the Conference Committee.

Chairman R. R. Proctor, and his Chicago Host Committee made the arrangements for the successful "kick-off" luncheon held in the Conrad Hilton Hotel in Chicago, June 11.

James D. Cunningham, President of Republic Flow Meters, Chairman of the Sponsoring Committee of the luncheon invited outstanding industrialists, professional and businessmen in the Chicago area to acquaint them with the magnitude of the Instrument Exhibit and Conference.

Richard Rimbach, Exhibits Manager reports that the Chicago Exhibit is a complete sell-out and over 15,000 persons interested in instrumentation will attend.

S. G. Eskin, Chairman of the Technical Program of the Conference announces 24 Technical Sessions with over 100 papers offered in the various phases of instrumentation.

SECTIONS AND MEMBERSHIP REPORT
8/1/46—3/1/53

Date	*Number of Members*	*Number of Sections*
8/46	1075	21
12/46	1650	23
4/47	2121	27
8/47	2296	32
3/48	2966	38
8/48	3280	41
3/49	3762	44
5/49	3908	44
9/49	3880	47
1/50	4224	49
6/50	4300	52
9/50	4298	52
3/51	4557	52
9/51	4549	52
3/52	5414	55
9/52	5597	58
3/53	6223	61

MEMBERSHIP RECORD BY SECTIONS AND GRADE AS OF MARCH 30, 1953

Sections	*FM	*AM	*SM	*Total*
Akron	35		1	36
Albuquerque	17	17		44
Aruba	30	1		31
Atlanta	40	1		41
Baltimore	130	3		133
Baton Rouge	29		6	35
Blue Ridge	31	4	5	40
Boston	150	1		151
California	290			290
Carolina Piedmont	60		1	61
Central Illinois	30	1		31
Central Indiana	38	48	1	87
Central New York	33	1		34
Central Ohio Valley	41			41
Charleston	94	2		96
Chicago	293	23	46	362
China Lake	14		1	15
Cincinnati	89	1		90
Cleveland	178	3	1	182
Columbus	30	4	1	35
Cumberland	38	3		41
Denver	76			76
Detroit	65	2		67
Eastern New York	79	1	9	89
Fox River Valley	47	3	2	52
Houston	195	7	3	205
Kalamazoo Valley	17	12		29
Kansas City	67	5		72
Lake Charles	22			22
Louisville	48	3		51
Montreal	96	1	12	109
Muscle Shoals	40	1	4	45
New Jersey	367	1		368
New York	259	6	23	288
Niagara Frontier	125	13	3	141
North Texas	15			15
Northern California	74			74
Northern Indiana	43	2	1	46
Oak Ridge	84			84
Paducah	126			126
Pan Handle	41	1		42
Permian Basin	57	2		59
Philadelphia	386	9		395
Pittsburgh	290	1		292
Presque Isle	27	1		28
Richland	109	7	43	159
Rochester	89		1	90
Sarnia	98	10		108
Sabine Neches	45		1	46
Seattle	77	4		81
Savannah River	78		4	82
South Texas	56	9		65
St. Louis	125	2		127
Tennessee	34	18	6	58
Toledo	50			50
Toronto	42	1		43
Tulsa	115	2		117
Twin City	34	10	1	45
Washington	93	59		152
Wayne County	112	38	3	153
Wilmington	108	1		109
Corporate Member	1			1
Foreign Members	32			32
Members At-Large	59			59
TOTAL MEMBERSHIP	5698	345	179	6223

*FM — Full Member — *AM — Associate Member — *SM — Student Member

Instrument Society of America

1319 ALLEGHENY AVENUE • PITTSBURGH 33, PA.

Plense send me ..... copies of the PROCEEDINGS OF THE SEVENTH NATIONAL INSTRUMENT CONFERENCE, held at Cleveland, Ohio, September 8 to 12, 1952.

Price $5.00 to ISA members. $10.00 to all others.

Name .....

Street .....

City ..... **State** .....

ISA Member - Yes ☐ No ☐ Payment herewith ☐ Send bill ☐

National Officers Nominated

The meeting of the Nominating Committee on May 4 in Chicago was marked by *excellence* of attendance, *excellence* of attitude of the members, *excellence* of qualified men available for office and *excellence* of the candidates finally selected.

Aruba is a long, long way from Chicago, otherwise the committee would have had 100 per cent turnout. Every member was present except the representative from this remote area—a really amazing accomplishment indicating great interest on the part of the members.

Fairness of attitude, lack of pressure (politics) and desire to select the men who could best serve ISA were evident throughout. Time was taken to thoroughly discuss the qualifications of each candidate. It was felt that every person who had permitted his name to be presented was offering to work and to make personal sacrifices for the welfare of the Society. The committee recognized this, expressed its appreciation, and gave full consideration to each candidate.

The most difficult part of the meeting was the need to turn down the majority of candidates. Each candidate for president was well known, a credit to ISA, and would unquestionably make a good officer; only a strong, vital organization could present such a group. It was necessary to select but one, and many ballots were taken before the will of the majority was evident.

Those chosen by the committee for President Hart to submit to the Council were:

W. A. WILDHACK

President: W. A. Wildhack.

Bill Wildhack has served as Councillor and President of the Washington Section. Nationally, he has been Chairman, Committee on Committees; Chairman, Instruments for Testing Committee; Chairman, Nominating Committee; Vice President, 1951; First Vice President, 1952; Secretary, 1953.

Since 1950, Bill has been Chief, Office of Basic Instrumentation, National Bureau of Standards. He has received repeated outside recognition, having served as Chairman, Gordon Research Conference on Instrumentation; Chairman, Committee on Scientific Equipment, National Research Council, 1947-1952, and has been recipient of a silver medal from the Royal Swedish Academy.

C. A. HANSEN, JR.

Vice President: Charles A. Hansen, Jr.

Charlie Hansen is a charter member of the Eastern New York Section, serving as President and Chairman of various committees. He also organized the Richland Section of ISA. Currently he is Chairman of the National Committee for Instrumentation of Production Processes.

Charlie graduated from Union College in 1930, taught high school science for seven years, joined the General Electric Company's General Engineering Laboratory in 1937, went to the Hanford plant in 1946 as Assistant Superintendent of the Instrument Department. In 1948 he returned to Schenectady to join the Knolls Atomic Power Laboratory as Instrument Unit Supervisor and, in this position, is responsible for instrumentation of atomic power reactors for submarines and power plants.

Recently he was appointed to the National Research Council and serves on the Subcommittee for Nuclear Measurements and Techniques.

A. H. PETERSON

Vice President: Axel H. Peterson.

Axel has been active in the Pittsburgh Section of ISA and is now Secretary of that Section. In 1951 he conducted at Houston the "Panel Discussion of Problems of Analysis Instrumentation" and in 1952 organized the Cleveland "Analytical Instrument Clinic."

At present he is a member of the Education Committee and since 1951 has been Chairman of the Analysis Instrumentation Committee.

He has a Ph. D. from Indiana University and heads the Department of Instrumentation, Mellon Institute.

Secretary: Robert T. Sheen.

Bob Sheen has been active in the Philadelphia Section and is Vice President of the Section. He is Vice President of the Society in charge of the General Relations Division.

Bob is a member of American Chemical Society; American Institute of Chemical Engineers; National Speakers Panel; Member of Pump Committee; American Society for Testing Materials; Secretary Committee D-19; American Water Works Association; Technical Association of Pump & Paper Industry; National Society of Professional Engineers; Manufacturers Golf & Country Club; and Aircraft Owners & Pilot Association. He is President of the Milton Roy Company.

Analytical Clinic Plans Completed

Dr. Axel H. Peterson, Chairman of the Analysis Instrumentation Committee of the ISA, has announced that plans for the Second Analytical Instrument Clinic to be held at the Eighth National Instrument Conference at Chicago, Illinois, September 21-25, 1953, have now been completed.

The Clinic, which will consist of a lecture and demonstration course on complex analytical instruments, will appeal particularly to technicians, chemists, physicists, and engineers. Electronic, optical, and mechanical design features will be covered as well as details of application.

The participating companies and the instruments to be demonstrated are:

Beckman Instruments, Inc.—analytical computers.

Consolidated Engineering Co.—dynamic recording systems—amplifiers, pickups, and oscillographs.

Gow-Mac Instrument Company—thermal conductivity gas analysis.

Minneapolis-Honeywell Regulator Co.—analytical application of recorders.

North American Philips Company—X-ray fluoresence spectrograph.

Process Controls, Div. of Baird Associates—non-dispersion infrared analyzers.

General Electric Company—radiation gaging.

Perkin-Elmer Corporation—dispersion infrared analyzers for the laboratory and plant.

Each company will repeat its three hour lecture and demonstration six times—morning and afternoon for three days. This method of presentation proved to be very successful at the Cleveland meeting. The program and registration forms may be obtained by writing to Dr. Axel H. Peterson, Mellon Institute, 4400 Fifth Avenue, Pittsburgh 13, Pennsylvania.

Instrument men living in the Milwaukee area are cordially invited to help organize the Milwaukee Section of the Instrument Society of America by contacting, Norman Janisse, Johnson Service Co., 507 E. Michigan St., Milwaukee 2, Wisconsin.

An organization meeting is planned for June 25th and the ISA Color film "Principles of Automatic Control" will be shown.

Ladies Don't Stay at Home!

Don't plan to stay at home this year while hubby attends the Eight National Instrument Conference and Exhibit to be held in Chicago this September.

Come to the Show, too, as the Ladies Welcoming Committee of Chicago have planned a wonderful, exciting program.

ISA President To Tour Europe

PORTER HART

Porter Hart, President of ISA will leave June 26 on a European Tour to extend an invitation to European instrument men, technical and scientific societies to attend ISA's First International Instrument Congress and Exposition to be held in Philadelphia, September 13-24, 1954.

Managing Director of the First International Instrument Congress, Richard Rimbach, has made arrangements for Mr. Hart to speak before technical and scientific groups in England, France, Germany, Switzerland and Italy on "Instrument Trends in the American Process Industries."

While in England, Messrs. Hart and Rimbach will attend the British Industries Exhibit in London. They plan to leave New York on June 26th and to return July 24.

Minutes of Nominating Committee Meeting May 4, 1953 Morrison Hotel, Chicago, Ill.

Members present were R. D. Webb, Chairman, A. A. Anderson, Edward C. Baran, C. M. Bosworth, William A. Crawford, J. H. Cuthbert, George Gardner, J. W. Graeb, Atherton Hastings, R. J. Karr, George Kellner, R. E. O'Neill, A. H. Shafer, and Carl Werstler. James L. Lopez was absent.

The meeting convened at approximately 10:00 A.M. The Chairman, with the concurrence of the members, appointed George Gardner Secretary for the day.

The Chairman then devoted a period to the reading and discussion of pertinent sections from the Nominating Committee Organization, Functions and Procedures.

Mr. Shafer read from the by-laws the portions which related to the nomination of officers, calling attention to the fact that the current by-laws, Article X, Section 1 permit the nominating committee to select more than one candidate for each office. *The Nominating Committee Organization, Functions and Procedures*, Section III (1) specifically states that one name shall be selected.

After some discussion it was recommended that study be given to reconciliation of these two points.

Mr. Baran moved that, for this meeting, the committee will select but one candidate for each office. Seconded, passed unanimously.

The method of voting during the meeting was discussed. It was decided to vote by secret ballot.

The qualifications of the nominees for the office of president were discussed. Individuals considered were H. C. Frost, E. S. Lee, R. T. Sheen, and W. A. Wildhack.

After extensive balloting it was moved and seconded that the name of W. A. Wildhack be submitted for the office of President. Passed unanimously.

Following this, the Chairman allotted a period for a thorough discussion of the qualifications for Vice President. Individuals considered were Chester S. Beard, Douglas M. Considine, J. L. Cottrell, George R. Frederich, H. B. Freeman, Charles A. Hansen, Mifflin S. Jacobs, Delmas C. Little, and Axel H. Peterson.

Meeting recessed at 12:45 P.M. and resumed at 2:15 P.M.

After extensive balloting on all candidates it was moved and seconded that the names of C. A. Hansen and A. H. Peterson be submitted for the offices of Vice Presidents. Passed unanimously.

Following this, attention was devoted to the qualifications of the candidates for Secretary. Individuals considered were Mifflin S. Jacobs and Robert T. Sheen.

After balloting it was moved and seconded that the name of R. T. Sheen be submitted for the office of Secretary. Passed unanimously.

The Chairman then invited discussion of nominating committee procedure. In general, this discussion was informal. The following are some of the points covered:

On the qualification form, the opinion was expressed that the form should be so arranged that differentiation could readily be made between a candidate's activity on a local committee and that on a national committee.

The suggestion was made that it would be advisable to have a photograph of the candidate, suitable for reproduction, submitted with the form. There was general agreement that this would be desirable. There was some discussion as to the advisability of having the chairman follow up on each qualification form, establishing the facts listed on the form and obtaining other relevant information.

The Chairman asked if the committee thought it preferable to have the candidates' signature appear on the form. The general opinion was that it was preferable. Mr. Crawford questioned the advisability of having the qualification form submitted through a member of the nominating committee in all cases. Shafer agreed. No decision. Baran suggested study of complete revision of form, allowing more room for candidates qualifications and subordinating prominence given to material not concerning candidates.

The suggestion was made that candidates' telephone number be included.

Crawford raised point as to advisability of discussion of location of Nominating Committee meeting immediately after personnel of each new Nominating Committee has been selected during the week of the Annual Conference. It was agreed that it would be advisable that the problem of meeting location be discussed at the time the new Nominating Committee was appointed.

This concluded the discussion of committee procedure.

Mr. Shafer presented a motion that the thanks of the committee members be extended to Chairman Webb for the very fine manner in which he conducted the meeting. Seconded by everybody. Passed unanimously.

Mr. Shafer made a motion to adjourn. Seconded and passed. Meeting adjourned at 4:05 P.M.

George Gardner
Secretary for May 4 Meeting

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA
1319 *Allegheny Ave., Pittsburgh* 33, *Pa.*

CHIEF DEVELOPMENT ENGINEER. Assume responsibility for extensive development program on pneumatic and hydraulic automatic control equipment including supervision of test laboratory. Creative and supervisory ability essential. Well paying, long range position with nationally known, medium sized concern. Location: Southwest. Box 810.

AIRCRAFT INSTRUMENT ENGINEER. Excellent position for engineering graduate with several years' experience in aircraft instrument design, production, or repair. This is a new position in a progressive, independent, research organization. Location: Columbus, Ohio. Box 811.

INSTRUMENT MECHANICS. Experienced in electronic and pneumatic control instruments as used in oil refinery or chemical plant. 40 hour week. Liberal benefit plans and good working conditions. Location: St. Louis area. Box 812.

JUNIOR ENGINEER. Assistant to Instrument Engineer in medium size food plant. Recent graduate interested in power and process control work. Experience not essential. Location: St. Louis industrial area. Box 813.

INSTRUMENT ENGINEER. Large pulp and newsprint mill now under construction. Engineering degree from college or univerality. Previous experience in paper industry instrumentation required; also, supervision of Instrument Repairmen. Location: Calhoun, Tennessee. Box 814.

ELECTRICAL AND INSTRUMENT ENGINEER. Responsible for the maintenance and installation of electrical equipment and instruments in a complete refinery of an independent oil company located in the southwest. Must have a degree in electrical engineering and at least 5 years experience in a refinery. Will assist Chief Engineer in developing specifications for electrical equipment and instruments. Will supervise the installation and maintenance of same. Salary open, subject to experience and qualifications. Location: Tulsa, Oklahoma. Box 815.

ENGINEER—INSTRUMENT. Experienced in design of panel instruments for airborne military use. Must be familiar with design criteria of all spring-return type instruments including D'Arsonval, ratiometer, drag-cup, and long-scale movements. Proven cleverness of design accepted in lieu of long experience in field. Location: Long Island, New York. Box 816.

Dynamic Behavior of Pneumatic Devices†

by L. A. GOULD** and P. E. SMITH, JR.**

Abstract. The study of dynamic behavior of a pneumatic controller is accomplished from the point of view of the controller's frequency response. The frequency response function (transfer function) is derived for a controller with an assumed ideal nozzle-flapper and relay to indicate the form of the ideal response of the controller. The nozzle-flapper and relay are then analysed as approximately linear devices to indicate the factors which limit the ideal controller response. The non-ideal response of a proportional controller is then derived. Experimental verification of the theoretical analysis follows.

MANY common pneumatic controllers are characterized by the schematic diagram shown in Fig. 1.

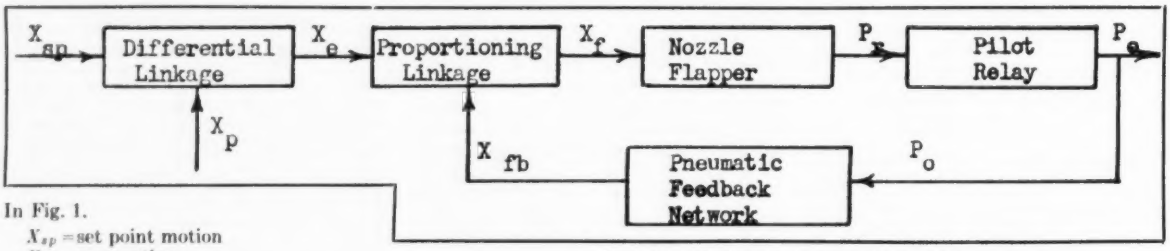

Fig. 1 Schematic diagram of a pneumatic controller.

In Fig. 1.

X_{sp} = set point motion
X_p = pen motion
X_e = $X_{sp} - X_p$ (error)
X_{fb} = feedback motion
X_f = flapper motion
P_r = nozzle back pressure
P_o = pilot relay output pressure (to diaphragm valve or similar load)

If the operation of the proportioning linkages of several different types of controllers is examined, it is generally found that the linkage action can be represented by an equivalent lever as shown in Fig. 2.

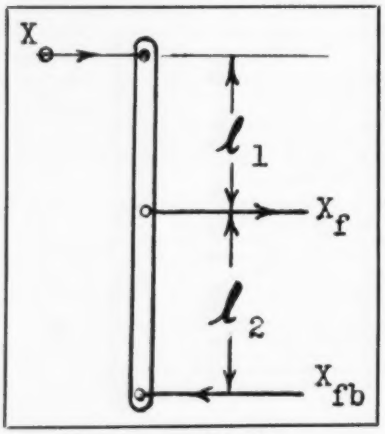

Fig. 2 Proportioning linkage.

The summing lever in Fig. 2 has a variable pivot point where the flapper is attached (x_f). The equation which represents this lever system is (for small motions):

$$X_f = \frac{l_1}{l_1+l_2}\left[\frac{l_2}{l_1}X_e - X_{fb}\right] \qquad (1)$$

If $K_1 \overset{\Delta}{=} \frac{l_1}{l_1+l_2} (<1)$ and $l_1+l_2 \overset{\Delta}{=} l$ then

$$\frac{l_2}{l_1} = \frac{l}{l_1} - 1 = \frac{1}{K_1} - 1 \quad (>0) \qquad (2)$$

or

$$X_f = K_1\left[\left(\frac{1}{K_1} - 1\right)X_e - X_{fb}\right] \qquad (3)$$

Combining Equation 3 with Equation 4 for the differential linkage

$$X_e = X_{sp} - X_p, \qquad (4)$$

the linkage system in the controller can be represented by the functional block diagram (signal flow diagram) of Fig. 3. The relationship between K_1 and the proportional band dial setting can be found by considering the physical construction of the actual controller being analyzed.

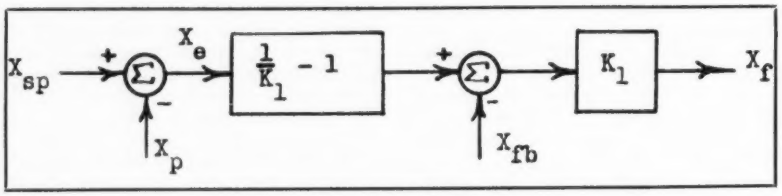

Fig. 3 Linkage system block diagram.

In the idealized case, assume that the response times of the nozzle flapper and pilot relay are negligible compared to the periods of the signals driving the controller. Under these conditions, the nozzle-flapper and relay may be represented as ideal amplifiers with no dynamic lag.

If $k_{nf} = P_r/X_f$ = static sensitivity of the nozzle-flapper* and $k_{pr} = P_o/P_r$ = static sensitivity of the pilot relay the block diagram of the entire controller is as shown in Fig. 4.

Types of Controller Actions

There are four basic types of controller actions:

(a) Proportional

(b) Proportional plus Reset

(c) Proportional plus Derivative

(d) Proportional plus Reset plus Derivative

In each case, the controller action is solely dependent upon the form of the pneumatic feedback network. It is important to note, however, that the nature of the proportioning linkage is such that a change in proportional band dial setting will alter the controller action. This is intuitively evident from Fig. 4. The adjustment of the proportional dial corresponds to adjusting K_1. This sensitivity is inside the feedback loop shown, and any change of K_1 will therefore alter the response of the closed loop (and, consequently, the controller action.)

(a) Proportional Action

The schematic diagram for the type of proportional controller considered in this discussion is shown in Fig. 5.

For this proportional controller the feedback network is the proportional bellows which converts the output pressure to the feedback motion. The feedback function is merely the static sensitivity of the proportional bellows.

**Massachusetts Institute of Technology, Dept. of Elec. Engr., Boston, Mass.

*See discussion on terminology in the appendix.

†Presented at the Instrument Society of America Seventh National Instrument Conference at Cleveland, Ohio, September 8-12, 1952.

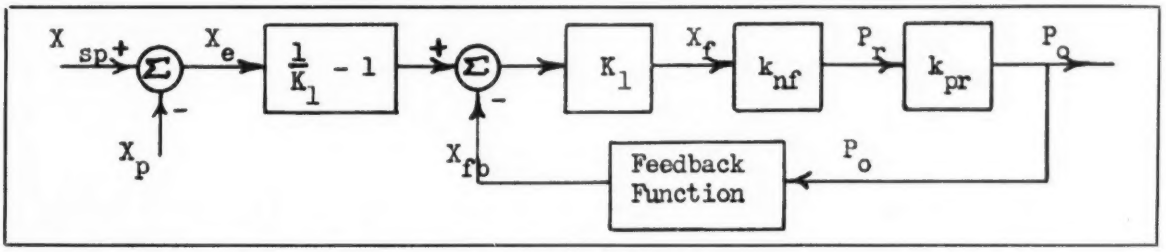

Fig. 4 Controller block diagram.

If $K_{fb} = X_{fl}/P_o$ = static sensitivity of the proportional bellows and $k_{nr} = P_o/X_f$ = static sensitivity of nozzle-flapper and pilot relay combination, the block diagram of the proportional controller is as shown in Fig. 6.

By reducing the diagram of Fig. 6, the response of the controller to a change in X_e is found to be:

$$\frac{P_o}{X_e} = \frac{(1-K_1)\,k_{nr}}{1+K_1 K_{fb} k_{nr}}, \quad 0 < K_1 < 1 \tag{5}$$

dial setting and K_1 for the controller under consideration is shown in Fig. 8.

It is seen from Fig. 7 that increasing the proportional band dial setting (increasing K_1—see Fig. 8) decreases the static sensitivity of the controller (P_o/X_e). However, increasing the proportional band setting also affects the high frequency response of the controller as will be pointed out later.

The mechanical arrangement in the controller is such that the motion which is fed back to the proportioning linkage is proportional to the difference, $P_o - P_R$; that is,

$$\frac{X_{fb}}{P_o - P_R} = K_{fb} \tag{6}$$

In Equation 6, K_{fb} = static sensitivity of proportional bellows*, (same as in Fig. 6.)

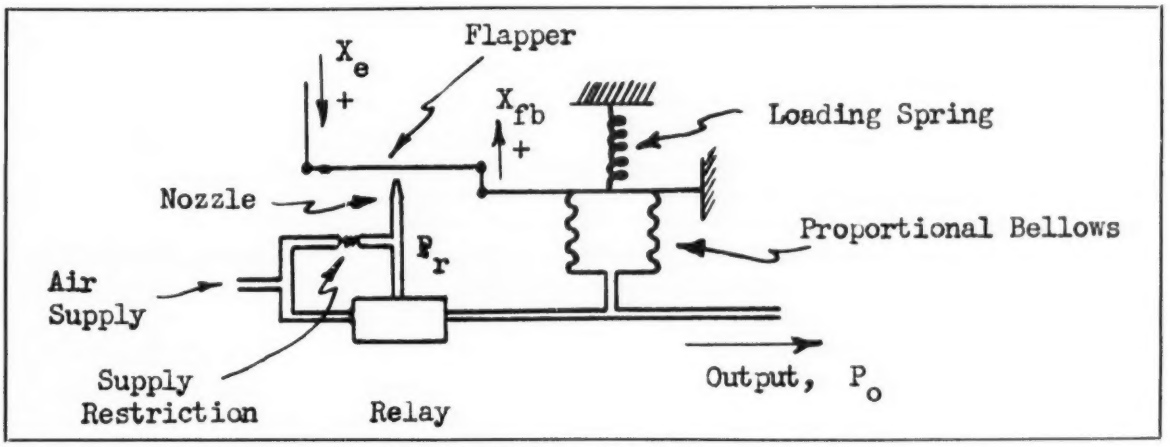

Fig. 5 Schematic diagram of a proportional controller.

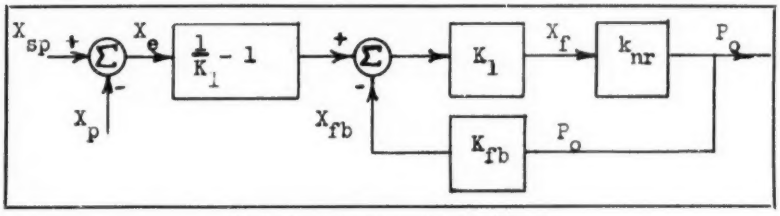

Fig. 6 Proportional controller block diagram.

In order to illustrate the variation of P_o/X_e with changes in K_1, values for K_{fb} and k_{nr} have been assumed to be:

$$K_{fb} = 6 \times 10^{-3} \text{ inch/psi}$$

$$k_{nr} = 1.25 \times 10^{4} \text{ psi/inch}$$

Fig. 7 is a plot of P_o/X_e vs proportional band dial setting for these assumed values. The relation between proportional band

(b) Proportional plus Reset Action

The schematic for the controller being considered is shown in Fig. 9.

For this type of controller the feedback network is arranged as shown in Fig. 10.

In Fig. 10, R_R = resistance of adjustable restriction

C_R = capacitance of reset volume

P_R = pressure in reset volume

The transfer function relating $P_o - P_R$ to P_o: is given by

$$\frac{P_o(s) - P_R(s)}{P_o(s)} = \frac{T_R s}{T_R s + 1} \tag{7}$$

where $T_R = R_R C_R$

The block diagram of the proportional plus reset controller is as shown in Fig. 11.

By reducing the diagram of Fig. 11, the response of the controller to a change in X_e is given by Equation 8:

$$\frac{P_o(s)}{X_e(s)} = (1-K_1)\,k_{nr}\frac{T_R s + 1}{\Delta_R T_R s + 1} \tag{8}$$

where $\Delta_R = 1 + K_1 k_{nr} k_{fb}$

*Note. The static sensitivity of the feedback networks in the proportional plus reset, proportional plus derivative, and three-action controllers is so defined as to make K_{fb} in these controllers equivalent in literal form to the definition of K_{fb} for the proportional controller (Figure 6).

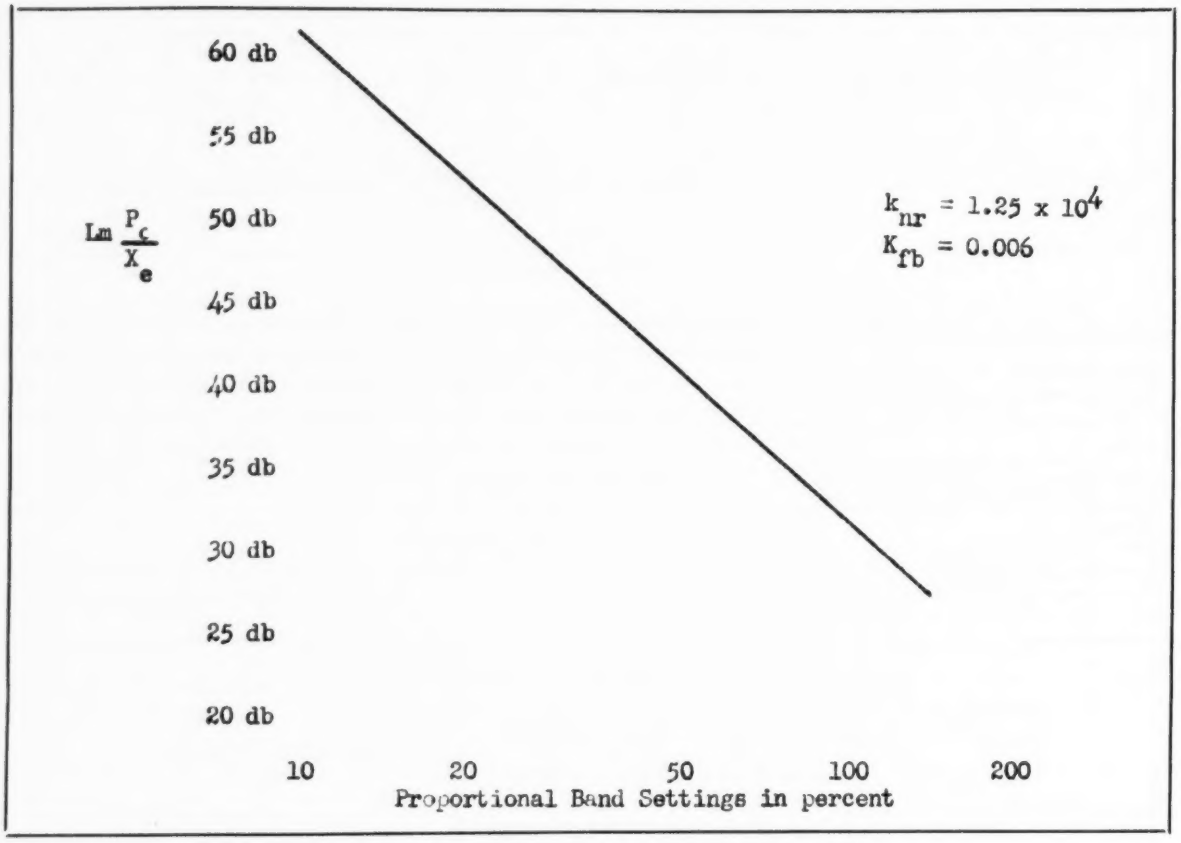

Fig. 7 Response of proportional controller for different proportional band settings.

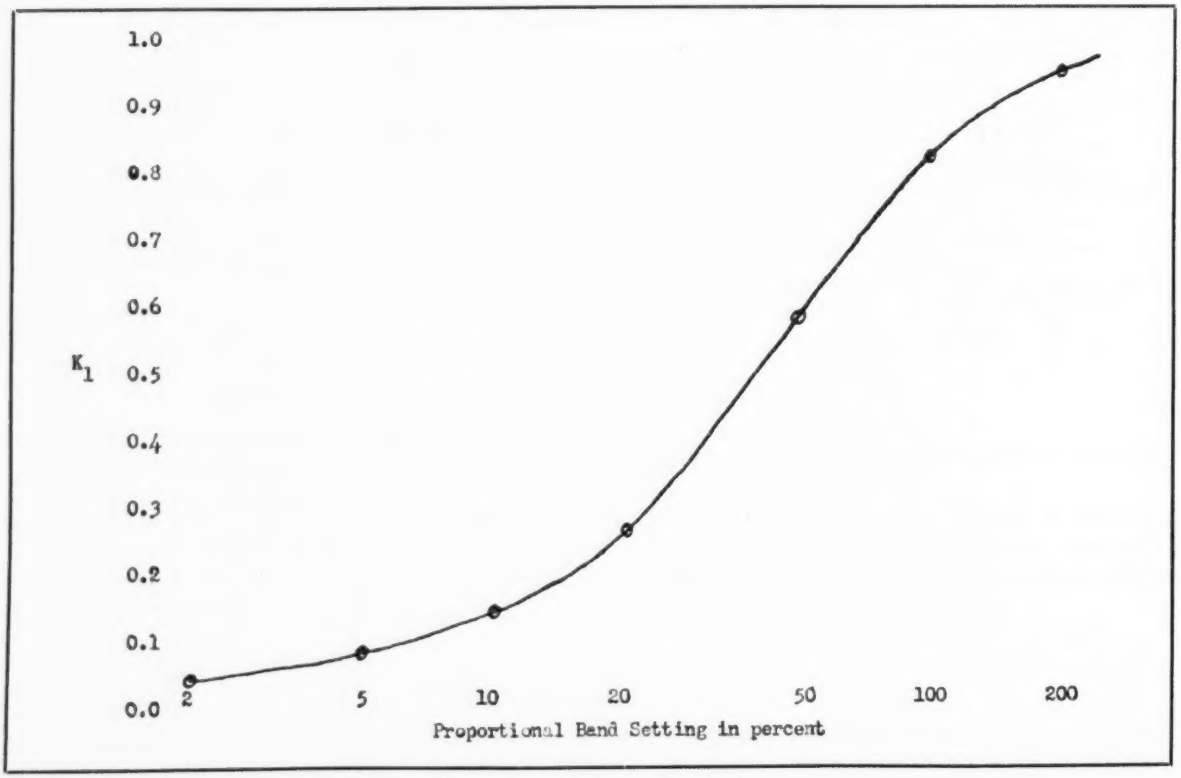

Fig. 8 Calibration of proportional band dial.

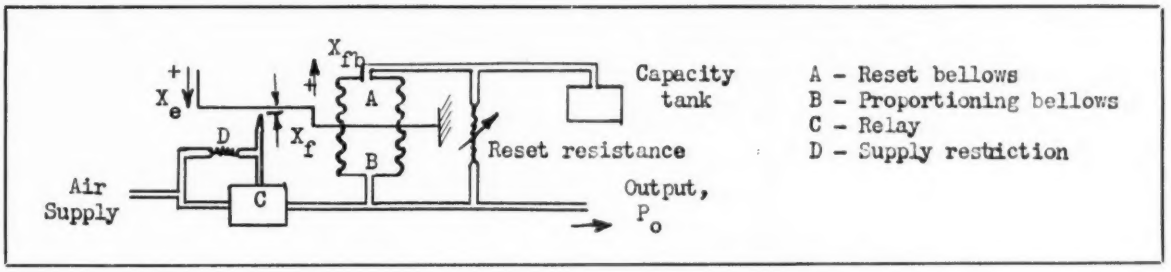

Fig. 9 Schematic diagram of proportional plus reset controller.

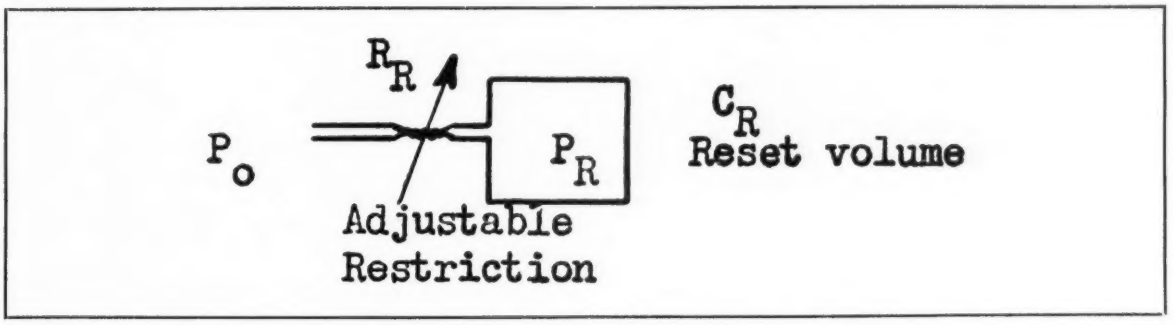

Fig. 10 Feedback network for proportional plus reset controller.

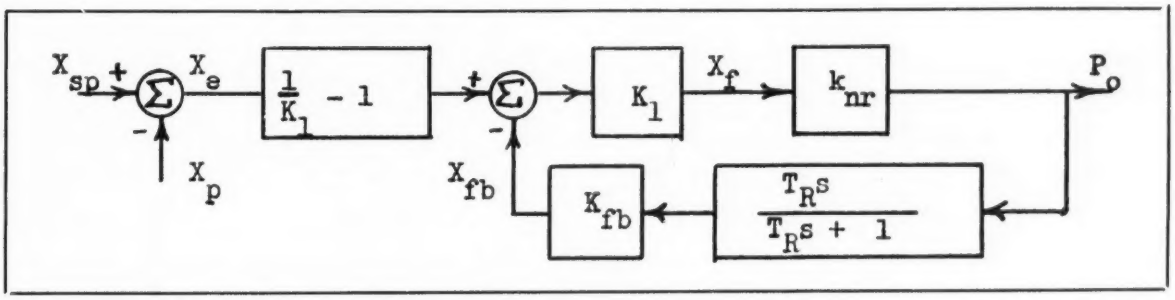

Fig. 11 Block diagram of proportional plus reset controller.

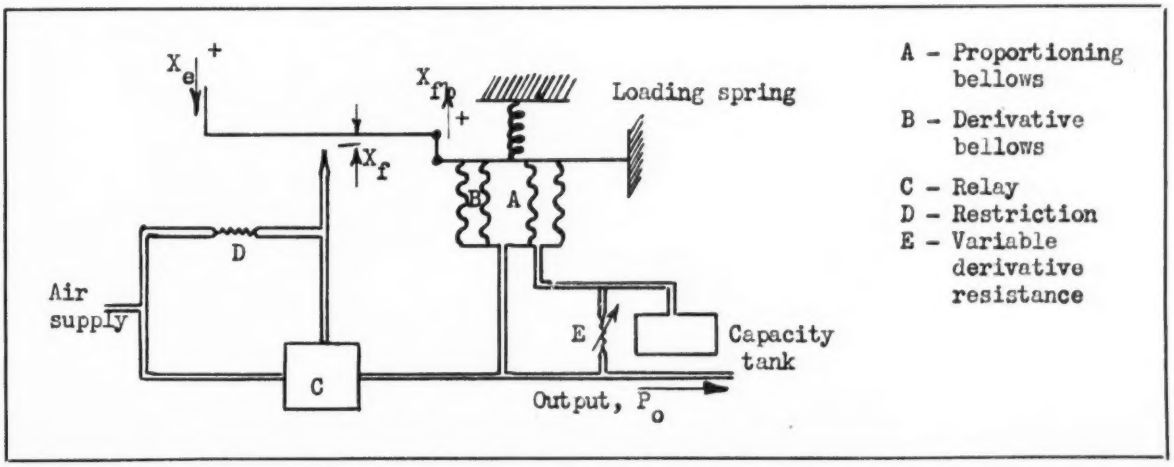

Fig. 13 Schematic diagram of proportional plus derivative controller.

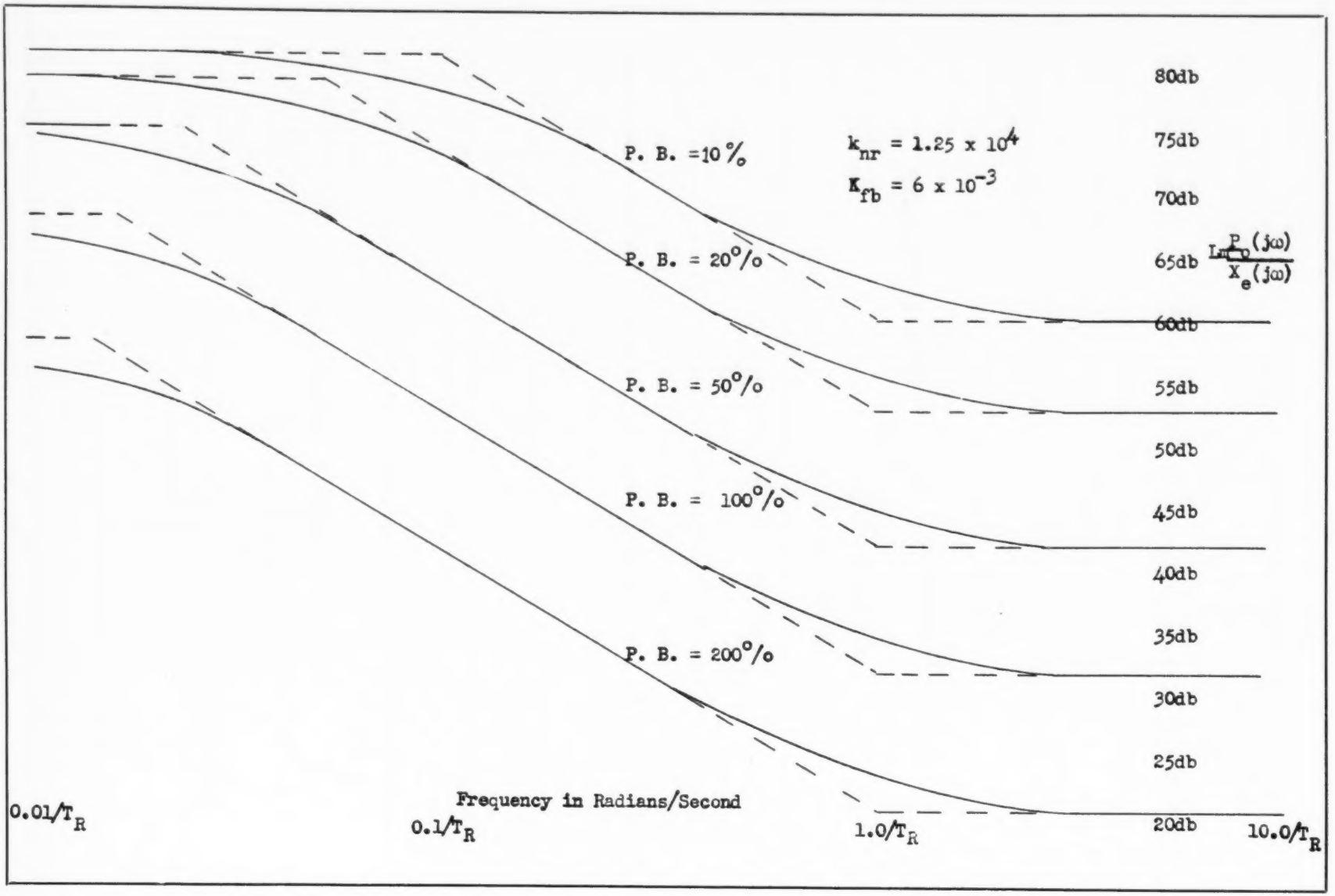

Fig. 12 Amplitude response of proportional plus reset controller for different proportional band settings.

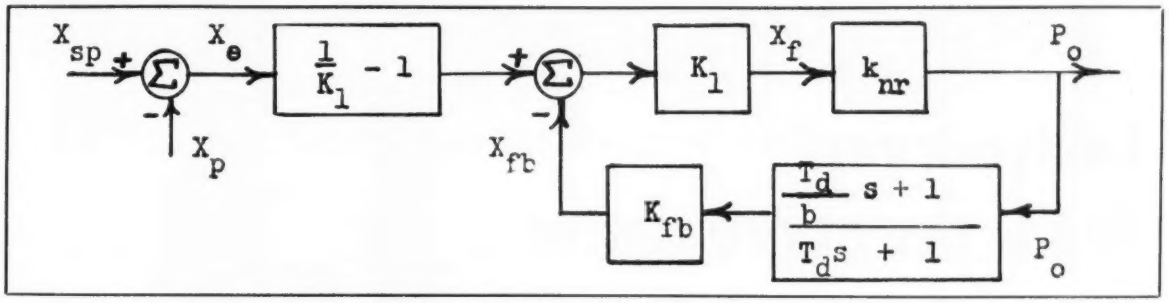

Fig. 14 Block diagram of proportional plus derivative controller.

For a given setting of reset time constant (T_R), the response of the proportional plus reset controller (Equation *8*) is a function of proportional band dial setting. In order to illustrate the effect of proportional band dial adjustment, the transfer function $\left[\frac{P_o\ (j\omega)}{X_e\ (j\omega)}\right]$ of the proportional plus reset controller is plotted in Fig. 12 for different settings of proportional band (for assumed values of $k_{nr} = 1.25 \times 10^4$ and $K_{fb} = 6 \times 10^{-3}$).

It is interesting to note that the magnitude of the proportional plus reset response for frequencies $\omega > 1/T_R$ is identical to the response of the proportional controller for the same proportional band setting (see Figs. 7 and 12). This means that the effective controller sensitivity (in the frequency region where stability is to be considered) of the proportional plus reset controller is the same as that of the proportional controller for the same proportional dial setting.

(c) Proportional plus Derivative Action

The schematic diagram for the controller under consideration is given in Fig. 13.

The feedback network arrangement is similar to that shown in Fig. 10. The difference in action is due to the mechanical arrangement. The motion fed back to the proportioning linkage is proportional to the quantity,

$$\frac{A_p P_o + A_d P_d}{A_p + A_d} \tag{9}$$

that is,

$$\frac{X_{fb}}{\frac{A_p}{A_t} P_o + \frac{A_d}{A_t} P_d} = K_{fb} \tag{10}$$

where A_d = area of derivative bellows
A_p = area of proportional bellows
P_d = pressure in derivative volume
$A_t = A_p + A_d$

K_{fb} = static sensitivity of bellows combination (same as in Fig. 6). The transfer function relating $\left[\frac{A_p}{A_t} P_o + \frac{A_d}{A_t} P_d\right]$ to P_o is given by:

$$\frac{\frac{A_p}{A_t} P_o \left[1 + \frac{A_d}{A_p} \frac{P_d}{P_o}\right]}{P_o} = \frac{\frac{T_d}{b} s + 1}{T_d s + 1} \tag{11}$$

where

$b = 1 + A_d/A_p = A_t/A_p \quad (> 1)$
$T_d = R_d C_d$
R_d = resistance of derivative restriction
C_d = capacitance of derivative volume

Thus the block diagram of the proportional plus derivative controller is as shown in Fig. 14.

By reducing the diagram of Fig. 14, the response of the controller to a change in X_e is found to be:

$$\frac{P_o(s)}{X_e(s)} = \frac{(1 - K_1)\ k_{nr}}{1 + K_1\ k_{nr}\ K_{fb}} \left[\frac{T_d\ s + 1}{(T_d/\alpha_d)\ s + 1}\right] \tag{12}$$

where: $\alpha_d = \dfrac{1 + K_1\ k_{nr}\ K_{fb}}{1 + (K_1\ K_{nr}\ K_{fb})/b}$

For a given setting of derivative time constant (T_d), the response of the proportional plus derivative controller (Equation *12*) is a function of proportional band. To illustrate the effect of proportional band adjustment, the transfer function $\left[\frac{P_o\ (j\omega)}{X_e\ (j\omega)}\right]$ of the proportional plus derivative controller is plotted in Fig. 15 for different values of proportional band setting (for assumed values of $k_{nr} = 1.25 \times 10^4$ and $K_{fb} = 6 \times 10^{-3}$). It should be noted that, for the controller tested, $b = 5$. The zero frequency sensitivity of the proportional plus derivative controller is the same as that of the proportional controller (compare Equations *5* and *12*).

(d) Proportional plus Reset plus Derivative Action (3 Action)

The schematic diagram for one type of three action controller is shown in Fig. 16.

The feedback network for this type of controller is shown in Fig. 17.

The mechanical arrangement is such that the motion fed back to the proportioning linkage is proportional to the quantity,

$$\frac{A_p}{A_R} P_o + \frac{A_d}{A_R} P_d - P_R;$$

i.e.,

$$\frac{X_{fb}}{\frac{A_p}{A_R} P_o + \frac{A_d}{A_R} P_d - P_R} = K_{fb} \tag{13}$$

where A_d = area of derivative bellows
A_p = area of proportional bellows
A_R = area of reset bellows
K_{fb} = static sensitivity of the bellows combination (same as in Fig. 6).

and $A_p + A_d = A_t$

To be continued

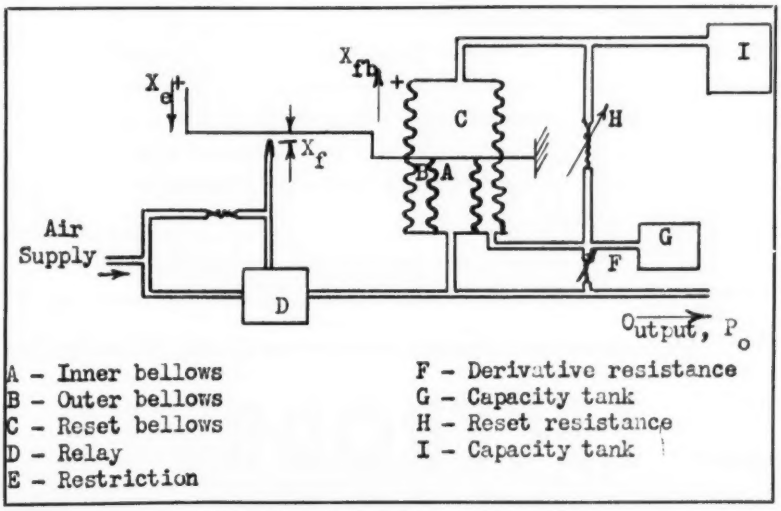

Fig. 16 Schematic diagram of three-action controller.

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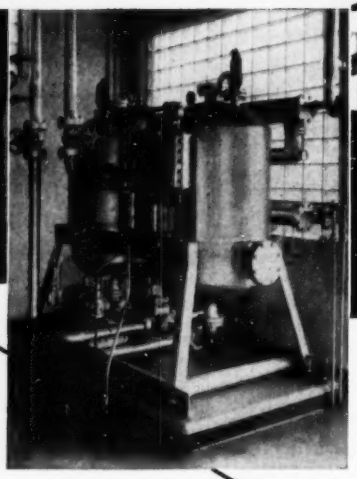

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Practical Considerations in

SELECTION OF CONTROL VALVES

Practical considerations in selection of a control valve include body design and construction, materials of construction, stuffing-box factors, choice of inner valve, and choice of valve operator.

By GLENN F. BROCKETT
Fisher Governor Co.

INSTRUMENT and control engineers often discuss control valves in terms of "valve characteristics," and give little thought to more mundane considerations that are really more important to the practical instrument man who must keep a plant operating from day to day. It is generally conceded that a percentage-type characteristic is preferred on applications where the pressure drop available at the valve decreases rapidly with increase in flow, and where widely varying flow rates are likely to be encountered, but that a parabolic or linear characteristic might theoretically be more suitable if there is a substantially constant pressure-drop across the valve. The fact that both types of characteristics are being used successfully on most applications involving control of pressure, liquid levels, temperature, and flow, is prima-facie evidence that the characteristic is not the most important factor in control-valve selection.

The subject of valve sizing has received considerable attention lately, and its importance should not be minimized. Control valves that are too small must be replaced; control valves that are too large have high initial and maintenance costs. Incorrect sizing is often caused by erroneous calculations of pressure conditions and flow requirements; and also by inaccurate and slip-shod sizing by manufacturers.

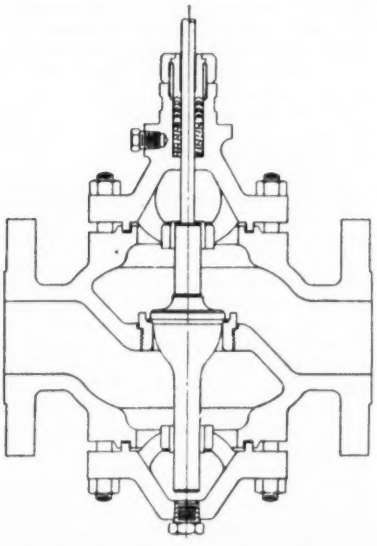


Fig. 1. Double-ported semi-balanced globe control-valve body.

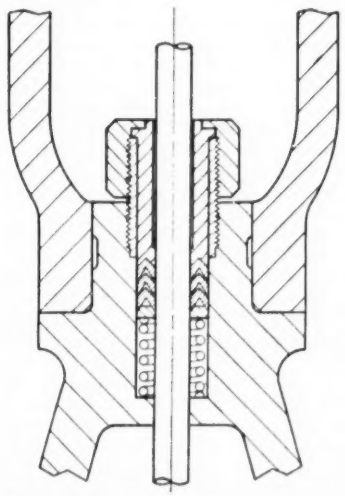


Fig. 2. Spring-loaded Teflon-packed stuffing box.

All recognized valve-sizing methods are based on coefficients determined by test. The C_v method used by most manufacturers gives accurate results in determining liquid capacities. However, when the liquid flow coefficient is used in conventional gas or steam formulae, the results are 15 percent in error at critical pressure drop. The empirical formulae for determining gas and steam capacities, developed from test by the Fisher Governor Company and published in the form of alignment charts, have a maximum error of 5 percent. They are based on coefficients determined by actual air flow tests, rather than hydraulic flow.

From the standpoint of the maintenance man, proper materials, quality workmanship, and good mechanical design are factors that should be given prime consideration in control-valve specifications. A valve that is generously designed and precisely machined from good materials usually can be expected to give trouble-free service as well as good control.

Valve Body

The valve body assembly is essentially a pressure-tight fitting that may be

July Meeting: Thursday, the 16th, Rio Hondo Country Club, Downey, Calif.

Feature: "Cylinder Operation of Automatic Control Valves" by Alexander Toben, Mgr. Air Hydraulics Div., Ledeen Mfg. Co.

screwed, welded, or flanged into a fluid flow line. A movable plunger or baffle in the fitting is positioned by an external operator, through a sliding stem or rotary shaft, to control the net flow area. Double-ported, semi-balanced globe-type valve bodies with sliding stems (Fig. 1) are used most widely in the process, gas, and power industries.

In the double-ported design, the top port is usually equal in diameter to the nominal pipe size of the body and is 1/16 to ⅛ inch larger than the bottom port. In a 2-inch valve, the top port would be 2 inches in diameter, and the bottom port 1⅞ inch. This permits easy assembly. The principal advantages of the double-ported body construction lies in the fact that it requires a minimum of power from the operator to position the inner valve. The unbalanced force at point of closure is equal to the product of the difference in port areas times the pressure drop.

A double-ported valve should not be expected to shut off tight. Owing to differences in coefficient of thermal expansion between the inner valve and body materials, and because of pressure and bolting stresses, a certain amount of leakage should be anticipated. Most manufacturers guarantee a new double-ported valve to leak less than ½ of 1 percent of its maximum capacity, but if at least 1 percent leakage cannot be tolerated, a double-ported metal-seated valve should not be specified.

Top- and bottom-guided valves (Fig. 1) are recommended if service conditions are severe. The guide bushings should be at least as long as their internal diameter; the larger the diameter, the better. The finish on the guiding surfaces should have a roughness value of less than 20 micro inches RMS, and the diametral clearances between the guide and bushing should be between 0.004 and 0.015 inch, depending on the size and operating temperatures of the valve. Good concentricity and alignment are essential.

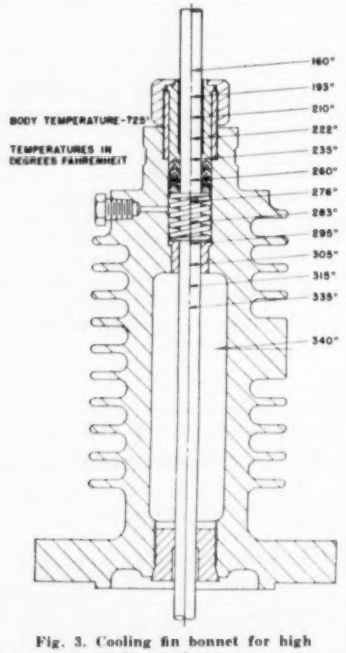


Fig. 3. Cooling fin bonnet for high temperatures.

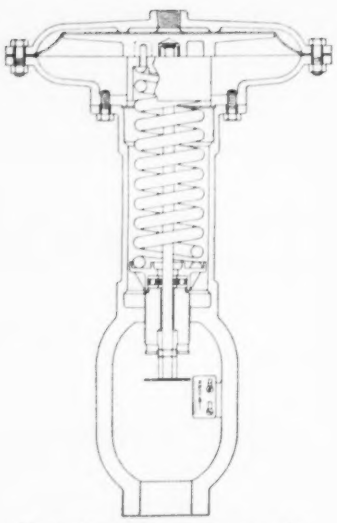


Fig. 4. Direct-acting diaphragm motor operator.

Skirt-guided V-port inner valves are cheaper than top- and bottom-guided ones, and are adequate for low-pressure-drop service.

Control-valve body-wall section should be at least equal to the values prescribed for flanged fittings, in ASA B16E 1939, and some manufacturers add ⅛ inch or more for corrosion allowance. Design should be such that changes in wall section are not abrupt, or porous castings will result.

Body construction of Fig. 1 is called reversible because the head or bonnet and blind flange are interchangeable. They may be assembled with the stem projecting from either end, and inner valve either "push down to open" or "push down to close." The bonnet and blind flange joint is not specifically defined by any code, but bolting and flange thickness should be adequate to stand hydrostatic tests per ASA B16E-1939, Supplement No. 1, without excessive stress. Gaskets should be retained on both internal and external diameter. Stud bolts are generally used in the bonnet and blind of valves with nominal pressure rating of 600 psi. and less. For high pressure ratings, bolt studs with nuts on both ends are generally used.

Valve-body materials must be strong enough to withstand operating and test temperatures and pressures, and must resist corrosion from the flowing fluid. A large majority of control valve body heads and blinds are made from high-tensile cast iron or cast carbon steel. The use of cast iron is limited by ASA code rulings to 250 psi. at 410 deg. F., and 400 psi. at 100 deg. F. Cast carbon steel, ASTM A216-47T, Grades WCA and WCB, is used for all higher pressures to 6,000 psi. and for temperatures to 750 deg. F. Generally a molybdenum-bearing alloy such as ASTM A217-49T, Grade WC1 or C5, is used for temperatures above 750 deg. F., and sometimes above 600 deg. F. Molybdenum gives the steel creep-resistance at high temperatures.

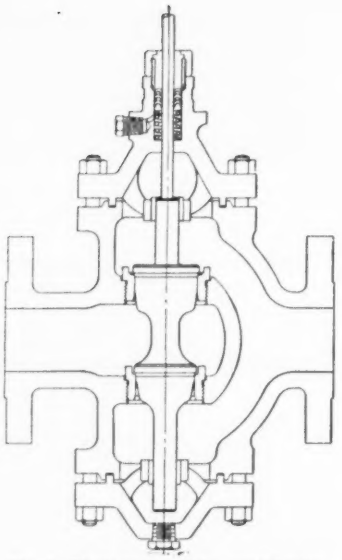


Fig. 5. Single-ported globe control-valve body assembly.

Body assemblies made from ASTM A296-49T, Grade CF8 or CF8M cast stainless steel, Hastelloy[1], Durimet[2] 20, various bronzes, and other alloys, are obtainable for handling corrosive fluids.

The inner valve, seat rings, valve stem, guide bushings, and stuffing-box parts often are referred to as "valve trim." AISI Type 304 or 316, or ASTM A296-49T, Grade CF8 and CF8M, which are the casting equivalents, are the most common materials for valve trim, with the exception of the guide bushings. The guide bushing should be made of material of a different hardness than the valve guides, or the two will gall and stick together. AISI Type 316 stainless steel, hardened to 38 to 42 Rockwell C, is widely used as guide bushing material, and is satisfactory on non-corrosive applications. AISI Type 322 is an age-hardening nickel-bearing stainless steel that is superior to Type 416 for guide bushings because of better corrosion resistance.

Hard surfacing materials, such as Stellite[3], Colmonoy[4], or Stoody[5], applied with an acetylene torch to valve seats and guides, are economical for high temperatures and pressure drops. These cobalt-base alloys are corrosion and erosion resistant, and are anti-galling at high temperatures. Small inner valves are often precision cast of the solid metal.

Stainless-steel trim with hardened chrome plating has been used extensively in recent years, with good results for resistance to erosion. Chromium

[1]Trade mark of the Haynes Stellite Co., Kokomo, Ind.
[2]Trade mark of the Duriron Co., Dayton, Ohio.
[3]Trade mark of the Haynes Stellite Co., Kokomo, Ind.
[4]Trade mark of the Wall Colmonoy Corp., Detroit, Mich.
[5]Trade mark of the Stoody Co., Whittier, Calif.

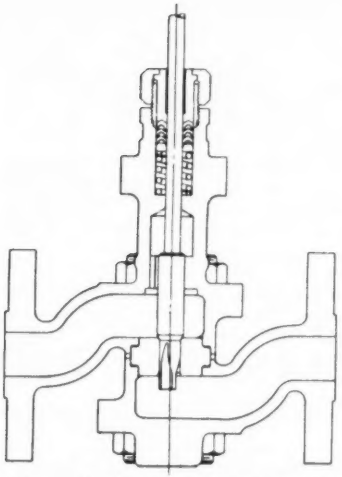


Fig. 6. Single-ported globe body used in the chemical industry.

plating is cheaper than hard facing, and is particularly applicable to large size plug valves.

Malcomizing[6], which is a patented surface-hardening process for stainless steel, also has proven successful on some high-pressure-drop applications, although it has not been used widely.

Other corrosion-resistant material such as Hastelloy, Monel, nickel, Inconel, Durimet 20 and bronze are used for valve trim in chemical service. Except for corrosion resistance, bronze is not recommended for valve trim unless service conditions are extremely mild; because of its extra service life, it is almost always economical to buy stainless steel rather than bronze.

Bonnet and blind flange bolting material for all steel control valves should be high-tensile molybdenum-bearing alloy. A desirable specification for studs is ASTM A193-49T, Class B7; for nuts, ASTM A194-48, Class 2H or 4. Heavy pattern nuts should always be used. Carbon-steel cap screws are generally acceptable for bolting heads and blinds on cast-iron bodies.

Stuffing Box

The control-valve stuffing box deserves considerable attention in specifications. For many years, molded graphited asbestos packing with a lubricant was universally used as a packing material, and is still widely used. A packing depth equal to six times the stem diameter is considered good practice. Many types of lubricants are used, although Silicones[7] are probably the most popular. This type of stuffing box requires frequent attention, and offers considerable frictional resistance to stem movement.

Packing rings formed under pressure from shredded Teflon[8], and Teflon impregnated asbestos, with or without a lubricant, is being used successfully.

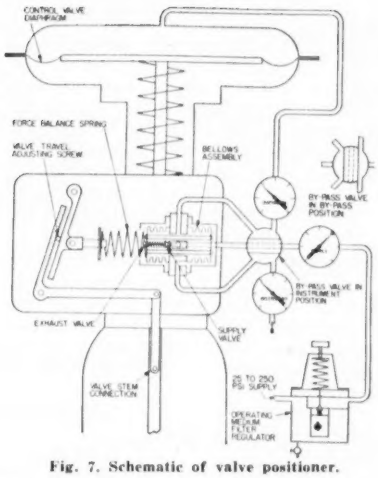


Fig. 7. Schematic of valve positioner.

Teflon has been applied widely as a stuffing-box packing for control valves in the form of chevron or V-rings (Fig. 2). Fig. 2 shows a spring-loaded construction that requires no adjustment, and is generally supplied without a lubricator. As Teflon is impervious to all chemicals except molten sodium, and withstands temperatures from plus 500 to minus 200 deg. F., it is practically a universal packing. However, as it sublimates and disappears as a gas at about 650 deg. F., it should be used with caution at high temperatures.

Teflon V-ring packing requires an exceptionally good finish on the valve stem and inside the stuffing box. For best results the stem finish should be under 10 micro inches RMS.

Cooling fins generally are supplied to protect stuffing-box packing if operating temperatures are in excess of 450 deg. F. However, it should be remembered that fins are only effective in cooling to the saturation temperature of the fluid at the operating pressure. Consequently, even though a cooling fin is provided, Teflon packing should not be used on steam at pressures above 650 psia., and should be used with caution on Dowtherm, if at all. The effectiveness of the cooling fin on superheated steam is illustrated in Fig. 3.

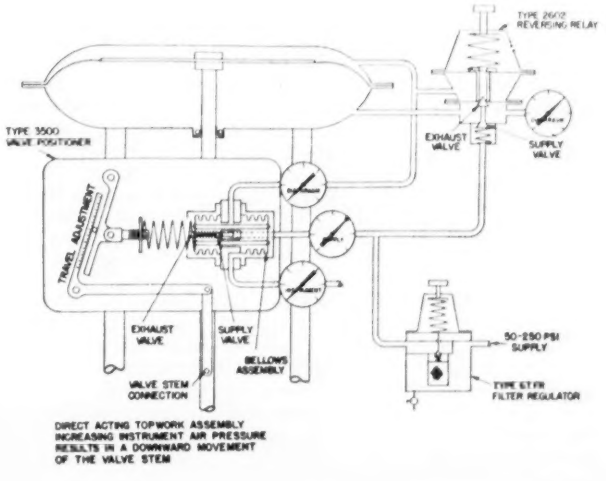
For extremely low temperatures, a plain extension head often is used. This acts in reverse of the cooling fin because it promotes absorption rather than dissipation of heat. It also serves to make the stuffing box accessible outside the pipe-line insulation. It is often traced with steam coils and may be almost any length desired.

Diaphragm Operator

The operator used most commonly on control valves consists of a flexible diaphragm opposed by a spring (Fig. 4). The yoke, or main frame that connects the diaphragm casing assembly to the body, should allow sufficient room for servicing the stuffing box and operating the adjusting screw, and should enclose the spring. It may be made of either iron or steel, but cast iron has definite advantages. If the yoke is fabricated from steel pipe or tubing, there is not sufficient room to service the stuffing box, and if made from a steel casting, it is too expensive. Also, a broken cast-iron yoke is easily detected and must be replaced immediately, whereas a bent steel yoke may escape detection and be a source of operating trouble.

The spring determines the pressure range of an operator. The compression rate tolerance on commercial springs is plus or minus 10 percent, but it is possible to get them at extra cost with a tolerance of plus or minus 5 percent. The spring end should be carefully closed and ground square, or excessive friction from side thrust will result. A large part of the hysteresis in the diaphragm operator may thus be attributable to the spring.

The diaphragm casing assembly should be as large in diameter as is economically feasible. Other things being equal, the larger the effective area of the diaphragm, and the longer the valve stroke, the more stable will be the control.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TYPE ET FR FILTER REGULATOR
DIRECT ACTING TOPWORK ASSEMBLY INCREASING INSTRUMENT AIR PRESSURE RESULTS IN A DOWNWARD MOVEMENT OF THE VALVE STEM

Fig. 8. Schematic of springless motor.

[6]Trade mark of the Chapman Valve Co., Indian Orchard, Mass.

[7]Trade mark of Dow Corning Corp., Midland, Mich.

[8]Trade mark of E. I. du Pont, Wilmington, Del.

The effective area of the diaphragm changes as it is stroked, being maximum at the start and minimum at the end. Properly molded diaphragms have less change in effective area than flat sheet, but are more expensive and not readily obtainable in emergencies.

Control-valve diaphragm material is usually 1/16-inch Neoprene with one ply of cotton or Nylon fabric. Nylon is stronger, but its use usually is not justified for operating pressure ranges of 3 to 15 psi. Cast iron and stamped steel are about equally effective as material for diaphragm casings, but steel is probably somewhat cheaper. Steel casings should be carefully finished to protect them from corrosion. If it is desirable that increasing air pressure move the valve stem upward, the so-called "reverse acting" operator is specified. Most reverse-acting operators have a stuffing box or seal of some kind at the diaphragm rod.

Single-seated Valves

Single-seated valves (Fig. 5) are used where the leakage in a double-ported valve cannot be tolerated. With metal seats they can be ground in to shut off drop tight, and can be expected to leak but little for long periods of service. Where service conditions permit, they can be furnished with composition seats that will not leak at all.

Single-ported valves have an unbalance force at point of closure equal to the port area times the pressure differential. This limits their use to pressure drops that can be handled by available operators. They should be specified wherever the pressure drop is low enough that the cost of the operator will not be excessive. Capacity of a single-seated body usually is between 70 and 90 percent of that of an equivalent-size double-ported body.

A type of single-seated body that is becoming increasingly popular in the smaller sizes (because of its lower cost and the ease with which the seat ring can be replaced) is shown in Fig. 6. It is particularly suitable for casting in alloys.

A single-seated body always should be installed in the flow line so that flow tends to open the inner valve; otherwise slamming and chattering will result as the valve approaches its seat.

Composition Disk Valves

Where absolutely tight shut-off is required in either single- or double-ported valves, composition disk or "O"-ring seat valves are supplied. The inner valve in this construction must be assembled through a flanged opening in the side of the body, and is fully balanced because both ports are the same size. This type of valve is not suitable for high pressure-drops, nor can it be used on temperatures above about 150 deg. because the "O" ring or disk is made of Neoprene or Buna N.

Valve Positioners

A valve positioner is essentially a relay inserted in the instrument air line between the instrument and the control-valve diaphragm. It uses a separate air supply for power and is reset by the movement of the valve stem. Its purpose is to assure exact positioning of the valve in accordance with instrument air send-out, and to eliminate the effect of operator hysteresis, stuffing-box friction, and inner-valve unbalance.

There are two basic designs of positioners in common use, ordinarily referred to as the force-balance and motion-balance types. An example of the

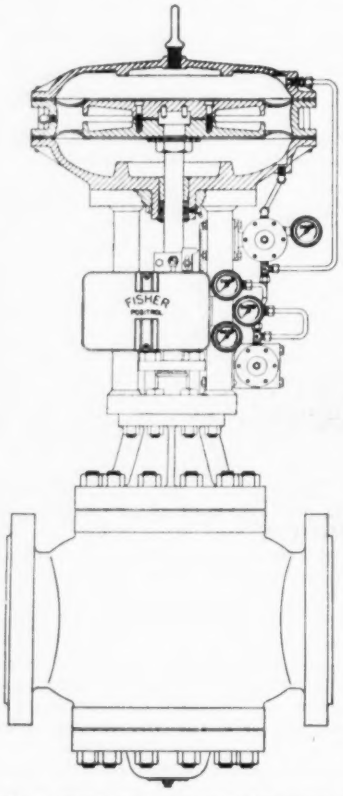


Fig. 9. Double-diaphragm springless motor on double-ported valve.

force-balance type of positioner is illustrated in Fig. 7. Note that this type of instrument balances the force from the instrument air pressure, acting on the bellows, against a spring that is loaded through a system of levers by movement of the valve stem.

The *motion-balance* type of instrument is operated by a flapper on an air nozzle, which actuates a relay. Instrument air in a bellows moves the flapper to change the nozzle pressure; valve stem motion through a linkage system resets it. The force-balance positioner is more popular because of its simplicity and rugged appearance. It is also more stable than the motion-balance type.

Positioners generally are specified on valves with large inner-valve unbalance, and on applications with considerable process lag, such as temperature or pH control. They are useful also when it is desirable to have a different pressure range on the diaphragm than is transmitted by the instrument, such as on a split-range control where one instrument is operating two valves.

There are probably more valve positioners sold than are needed in most process plants. It isn't unusual to see a valve equipped with a positioner that has been by-passed and is not being used, and probably many more valves would operate just as well if the positioners were by-passed. This is especially true since the advent of Teflon-packed stuffing boxes, which has taken a good bit of the friction out of control-valve operation.

Springless Motors

Springless motors are a fairly recent development in control-valve operators and are becoming popular. They utilize air on both sides of the diaphragm instead of air on one side and a spring on the other. They are generally used on single-seated valves with high pressure-drops, or on large valves requiring considerable power to operate.

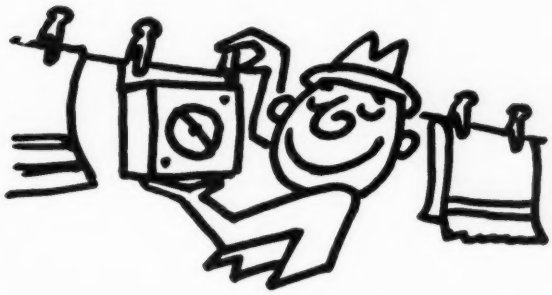
One type of springless motor is loaded with a constant air-pressure on one side of the diaphragm, and a variable pressure on the other. Another type is loaded with pressure varying inversely on both sides. Both types are operated by valve positioners, and usually at a higher pressure range than 3 to 15 psi.; 0 to 30 psi. is common and 0 to 50 psi. has been used. It is practical to use higher pressure ranges on this type of operator because a large and expensive spring is not required.

A typical springless motor with inversely varying air pressure on both sides of the diaphragm is shown in Fig. 8. The positioner feeds one side of the diaphragm directly, and also loads a reversing relay which feeds air to the other side in inverse ratio to its loading pressure. Thus, as the pressure increases 1 psi. on one side, it decreases 1 psi. on the other. With this type of operator, full supply pressure is available on either side of the diaphragm, with zero on the other, at any time in the valve stroke.

The double-diaphragm assembly, shown in Fig. 9, is used to give stability on large double-ported valves where there is likely to be a reversal of stem forces as the valve travels. It is probably not necessary on single-seated bodies when the inner valve unbalance force is always in one direction.

The springless motor is more stable than the conventional spring and diaphragm type because the effective spring rate of the high-pressure air on the diaphragm is higher than that of a 3-to-15-psi. range spring.

A springless motor is basically no more expensive than the conventional spring and diaphragm operator with a positioner, and it has many times the power. It will probably be used on more and more applications in the future.



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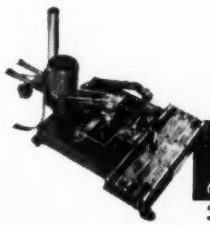

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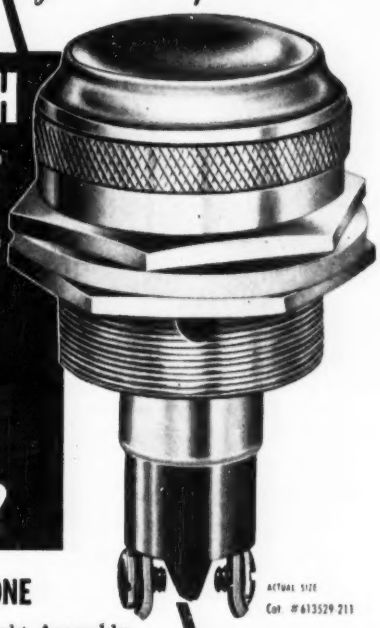

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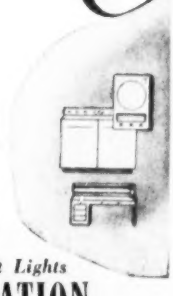

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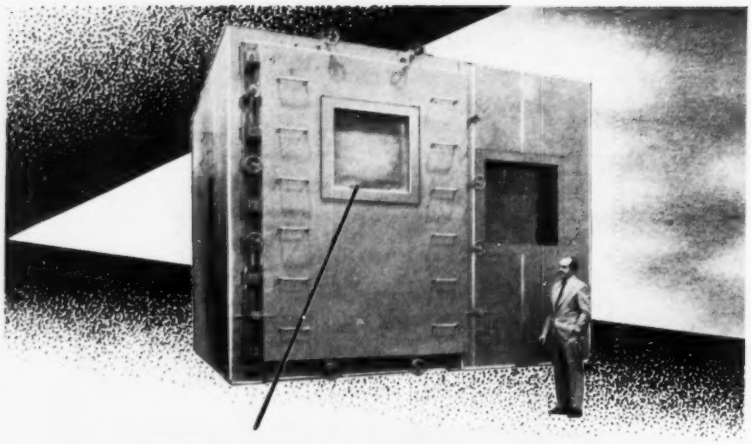

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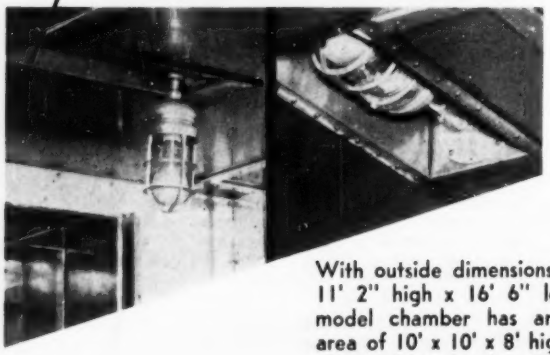

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CALORIMETER

continued from page 875

Installation

The Cutler-Hammer recording calorimeter is highly sensitive. Therefore, when it is subjected to vibration, drafts, any large variation in temperature, or contaminated atmosphere, serious errors in heating value determinations and difficulties in maintenance will undoubtedly occur.

If the calorimeter is subjected to extreme vibration, there will be difficulty in keeping the burner flame burning. Vibration often may be compensated for by placing the tank unit and recorder unit on an insulating base.

The recording calorimeter never should be installed at a location where the atmospheric air will contain any increments of combustible gases. Obviously a mixture of air and combustible gases entering the combustion-air meter will result in an average recorded Btu much higher than that of the gas under test. There is no available data concerning the maximum percentage of combustible gas allowable in the combustion air without apparent error in the determination, but this percentage is extremely small. A combustion-air hood can be procured, which covers the combustion air meter and is piped to a source of pure air not too distant from the calorimeter. However, unless the intake of this vent is properly constructed and installed, varying pressures of combustion-air at the meter, due to drafts, may be encountered, which will result in slight inaccuracies. The effect of noticeable quantities of dust in the air on the life of moving parts of the mechanism is obvious.

The Cutler-Hammer recording calorimeter is designed to operate at maximum efficiency at room temperature of from 60 to 90 deg. F. A principal aid to accuracy in test results is the maintenance of constant temperature over a considerable period of time. The ideal location would be an air-conditioned room where the temperature variant is not over 4 deg. F., and where a constant supply of pure filtered air is available.

It is absolutely necessary that both the tank unit and recorder unit be accurately leveled, and that the original level position be maintained. As the calorimeter tank unit weighs nearly 900 pounds and the recorder unit approximately 175 pounds, care should be taken against the possibility of the floor sagging under this weight, thereby altering the position of the instrument and destroying the calibration settings.

After the electrical circuits have been installed, the Tank Unit is filled with distilled water as near as possible to the level of the three water level gauges, and the reserve tank filled to a level about an inch below the drain pipe of the overflow weir. If tap water

of exceptional purity is obtainable, it may be used, but from a standpoint of maintenance and long life, distilled water is far superior to tap water of even the highest quality.

The piping used should be as small in diameter as will insure delivery of an ample quantity of gas. If the test gas contains no hydrogen sulphide, ⅜-inch copper tubing makes excellent piping because it may be run to the tank unit with but one connecting joint. If the test gas contains hydrogen sulphide, ¼-inch iron pipe may be used in conjunction with a purifier designed to purify the gas at a rate of not less than four cubic feet an hour.

Initial Calibration

Strict adherence to calibration technique results in an initial accuracy greatly exceeding the accuracy guaranteed by the manufacturer.

Air-Gas Ratio

This is the first check made in the series of calibration checks preliminary to putting the calorimeter into operation. The object of this test is to establish the fixed predetermined volume relation between the metered gas sample and the heat-absorbing air. It is performed by use of special air-gas ratio test gears, furnished by the manufacturer, and a delicately balanced water-sealed prover bell with a calibrated index reading in terms of movement of the prover bell for each 1 percent capacity on the air meter per revolution. The gas meter is so connected that it pumps air from the prover bell while the heat-absorbing air meter pumps air into the bell. If the air-gas ratio is correct, no rise or fall of the prover bell is indicated by the scale index.

Hydrogen Check

The over-all accuracy of the recording calorimeter can be checked effectively by burning a pure gas such as hydrogen and comparing it with the theoretical reading.

Hydrogen differs from most commercial gases in both combustion characteristic and specific gravity. Therefore, a heating value of 319.6 Btu is recognized for test hydrogen on standard scale instruments.

For practical reasons it is desirable to use gas meter test gears which give a reading higher on the scale than that used for commercial gases. A set of hydrogen test gears is therefore furnished with each instrument.

The hydrogen can be made by using "Hydrone," an alloy obtainable from Cutler-Hammer, or a hydrogen generator (Fig. 4) may be constructed. It is advisable to bubble the hydrogen generated through a 1.0-percent sulphuric-acid solution by means of a wash bottle inserted in the feeder line between the generator and the calorimeter tank unit. The hydrogen pressure must be constantly maintained at 1.0-inch water

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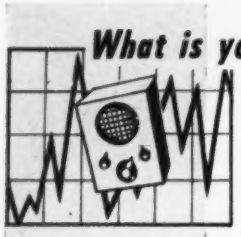

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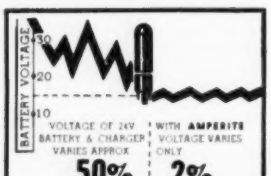

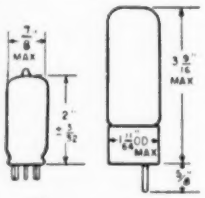

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column at the calorimeter inlet orifice throughout the test.

If the sensitivity, mechanical balance, and cold balance of the instrument are checked, the hydrogen test should be reproduceable to 0.3 percent of full-scale reading.

Calibration Check Using Reference Sample

Where it is possible to obtain a reference gas of known purity and with a heating value close to or within the daily operational range of the calorimeter, an additional check may be made to give added assurance of overall accuracy. The writer has had considerable experience using methane gas with a purity of 99.8 percent. It is stored in a high-pressure cylinder of the type used for oxygen, at a pressure of 1500 psi. Numerous analyses have established the Btu of this reference sample at 999.7 (saturated) or, for practical calibration purposes, 1000 Btu (saturated).

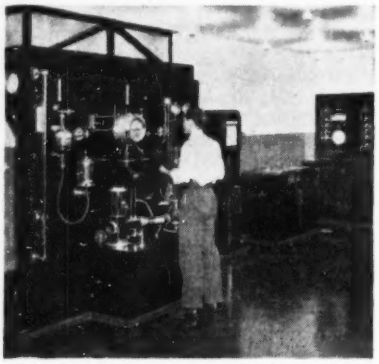

Fig. 5. Arrangement for comparison tests between water-flow and recording calorimeters.

One advantage of using this reference sample is that, when testing a calorimeter which normally operates on a gas of from 900 to 1200 Btu, the calibration check may be made without the necessity of changing gears or orifices. The sample is fed directly into the instrument and under ordinary conditions a reading is obtained within an hour.

The heating value of the reference sample gas must be established beyond question. This can be accomplished by an accurate standardization of a particular cylinder of this gas by means of analysis and repeated water-flow calorimeter tests or by checking with a recording calorimeter which has recently been standardized using hydrogen generated from "Hydrone."

Calibration Checks Using the Water-Flow Calorimeter

When conducting calibration checks by means of the water-flow calorimeter the test sample should be drawn from the same container or test holder as the gas being tested by the recording calorimeter. This will eliminate differences in results between the two instruments caused by different time lags or possible changes in the heating value of the gas. The test should be made by

an experienced operator using an authoritive procedure such as those given by the A.S.T.M. Designation D-900-48 or "Fuel Gas Calorimetry, Water-Flow Method," *Proceedings of the Pacific Coast Gas Association*, 1941. The comparison values obtained by the water-flow calorimeter should be evaluated upon results of a series of tests rather than upon the results obtained by one or two tests. Fig. 5 shows a convenient arrangement for comparison tests between the water-flow calorimeter and recording calorimeter. Not shown is the common sample container for both instruments, which is located behind the water-flow calorimeter panel.

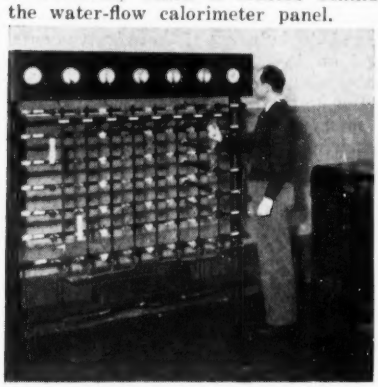

Fig. 6. Control manifold for measuring seven gas streams.

Maintenance and Operation

A system has been developed using only two simple forms, on which are reported the results of a daily inspection, a weekly inspection and calibration, and a six-month thorough inspection. The daily routine requires no more than thirty minutes per calorimeter. The weekly inspection and calibration is the most important operation and is the most carefully recorded; it requires about 2¼ hours per instrument. In the six-month inspection, the tank water is drained and bearings, shafts, etc. are inspected.

The time-consuming air-gas ratio and hydrogen checks are performed only when shown necessary by reference-sample check indications—seldom more than twice a year.

Auxiliary Equipment

Control Manifold

Where it is necessary to check the Btu of various gas streams, the flexibility of the recording calorimeter may be increased by the use of a control manifold (Fig. 6). The manifold facilitates changing from one gas stream to another, and also constitutes a visual indication of which particular gas is on test.

Calorimeter Carrier

As the moving and placing into position of the 900-lb. calorimeter tank unit is extremely difficult, a combination lift and carrier (Fig. 1) has been designed that has a lifting screw mechanism and casters. This permits precise placing of the unit with minimum effort.

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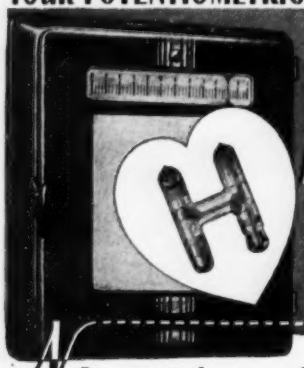

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GRAPHIC PANEL

continued from page 871

units. These alarm units provide a visual indication of abnormal conditions by means of alarm lights, which may be placed appropriately in the flow diagram, or by audible alarm if desired.

The recent advances in pneumatic controller designs have been paralleled in the electrical types. All of the basic modes of control are available in the new improved designs employing the latest developments in electronic circuits. For example, vane-type controllers are available which provide extremely close switching action. One instrument manufacturer is now marketing a line of electrical instruments which essentially duplicate all the functions of pneumatic instruments. Electrical instruments reduce transmission lags to an insignificant value, and the influence of these instruments on graphic panels and on instrumentation in general is certain to be of considerable importance

Since their introduction to the process industries, graphic panels have survived many variations and phases. One of the still unsettled arguments concerns the amount of detail which should be shown on the control panel. Fig. 4 is a panel on which much detail has been added. Fig. 5 is a conventional panel on an identical unit. In my opinion the latter is by far the better design for this application.

Advantages of Graphic Panels

The advantages of the graphic panel are (1) the operator can see at a glance all the important process variables and their relationship to each other, (2) he can, without leaving the control room, make control changes and immediately observe the effect on other variables, (3) he can frequently spot incipient troubles and make corrections before they develop into shut-downs, (4) the remote-set controllers, supervised from the graphic panel, provide improved flow control, (5) process superintendents and other supervisory personnel can easily follow the graphic flow sheet and know whether the unit is operating normally, (6) control rooms may be made smaller and less expensive, (7) the instruments are readily interchangeable, thus reducing both field repairs and out-of-service time, and (8) prefabricated boards are easier and more economical to install.

Disadvantages of Graphic Panels

(1) The casual observer, impressed by the attractive appearance of the panel, is inclined to consider it the final answer to all control problems. This frequently leads to its being installed in places where it is neither economical nor desirable. For example, a vacuum distillation process is simple, products have high flash points, all control lines are short, and no pneumatic transmission lags are involved. A graphic panel would be neither economical nor desirable, yet many are installed on just such applications.

(2) Designers become fascinated with the appearance of the panel, and sacrifice function for form. A good design considers both the front and rear of the panel board.

(3) Failure to consider the rear of the panel while designing the flow picture usually leads to a veritable rat's nest of piping and wiring that is difficult to install and service.

(4) Operators tend to confuse the panel with the process. They develop a tendency to stay in the control room and lose contact with the equipment.

(5) Union labor frequently refuses to install prefabricated panels.

To conclude, the graphic panel is here to stay. Like other developments in the instrument field, it offers many advantages—when installed with reason and proper justification.

The disadvantages are not as much in the graphic panel as in the tendency toward overdoing it.

Acknowledgements

Moore Products Company, Pannellit, Inc., and several friends have been of considerable help in the preparation of this article.

INFRARED ANALYZER

continued from page 873

formed by this instrument monitors the normal-butane production from this system, which indicates the averaged isobutane content of the kettle product. These are good examples of the material-balance type of plant analyses. Analyzers are used also as guides for operator control, with the time lag taken into account.

For automatic-control use, sampling of the material on a plate in the column is preferred. From the nature of the concentration gradients of the various components throughout the column, it is possible to find regions of rapid concentration change of key components in the presence of only small concentrations of light and heavy components; these are the best places for sampling for automatic-control purposes. In general, these sensitive sample locations occur about midway between the bottom of the column and the feed entry, and midway between the feed entry and the top of the column. Therefore, we have automatic control analyzers taking samples from the 5th, 10th, 16th, 24th, or 68th plate of columns separating a wide variety of components.

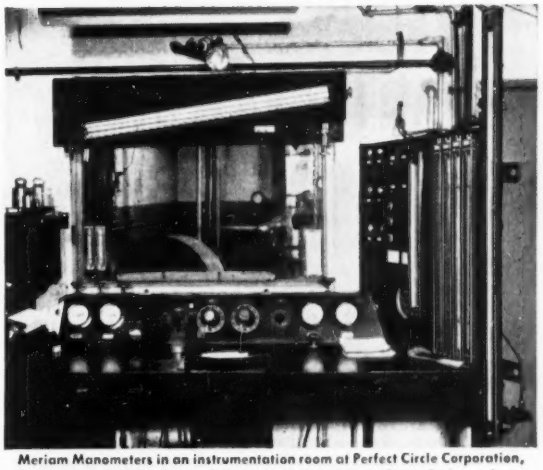
Automatic Control

As most control systems use air-operated control valves, the potentiometer recorder is equipped with an air control system utilizing proportional band and reset features. The controlled air output from the recorder-controller then is used to position a motor valve on a stream which has a direct influence on the separation being made. As the largest streams in a fractioning system are the reboiling steam, reflux, and feed flows, it has been our experience that it is advisable to use the analyzer to control the rate of flow of overhead product, kettle product, or possibly feed. With other flows controlled by rate-of-flow or liquid-level instruments, the system becomes in effect a material-balance type of control with the analyzer determining the percentage of the feed taken off as one product so that a specific composition is maintained at the analyzer's sample point. By difference, then, the other product is taken off under liquid-level control. As reboiling steam and reflux are directly related, one is put on rate-of-flow control and the other on liquid-level control. It is particularly important to adjust these two instruments so that smooth operation is obtained because the quantities of materials handled are large; thus, under near-maximum load conditions, moderate changes in rates could cause column flooding. A pneumatic-set rate-of-flow control may be used with the liquid-level control overriding it to prevent large sudden changes in rate. Using a pneumatic-set rate-of-flow control on the stream which the analyzer is to control results in a stable system and provides protection against analyzer or sample-system failure.

One typical system used in Phillips' plants uses rate-of-flow control of feed and steam, accumulator liquid-level control of reflux, reboiler liquid-level control of kettle product, and analyzer control of overhead product. Here, pneumatic-set rate-of-flow control is used on either or both reflux and overhead product with liquid level and analyzer overrides, respectively. A second system differs from the first only in that the reflux is on rate-of-flow control and the steam is on accumulator liquid-level control. Other composition analyzers may be used in these control systems. For example, the second system is in use on five fractionators with differential refractometers setting the overhead-product rate-of-flow control; the results are excellent. Again, somewhat off the subject of butane splitters but still on fractionator control, Phillips' experience in control of furfural extractive distillation columns has shown that analyzer override control is desirable and gratifying economically. In these applications, analyzer control of lean solvent feed or reboiler steam actuates the material-balance type of control system.

Sample Preparation

The sample to be analyzed usually is taken from a vessel or line as a liquid or as a vapor at its dew point, and therefore requires vaporization and pressure reduction. Vaporizer-regulators have been constructed and are used on near-



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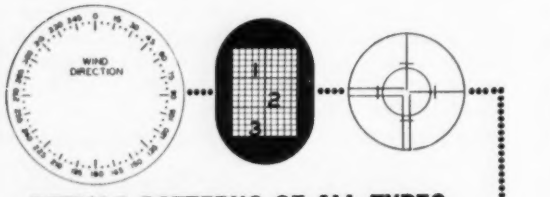

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ly all installations so that the heat of vaporization is supplied by steam at the point of pressure reduction. As small amounts of pipe scale and dirt are found in the cleanest streams, filters are used to prevent clogging of pressure-reducing valves. Water and heavy liquid hydrocarbons often are present in the sample streams; these are removed or brought to constant trace amounts by means of sample-washing and scrubbing equipment.

To keep a relatively constant flow-rate of sample to the instrument, a differential-pressure type of flow controller is used with a rotameter flow indicator. A constant sample flow-rate also insures a constant analyzer cell pressure and temperature. To select and direct the various gas streams required for multistream analysis and automatic standardization of the infrared analyzer, solenoid or cyclic valves are used in conjunction with a timing circuit within the analyzer. Portions of the sample system and the switching valves are built into the analyzer itself so that the proper components are included in the analyzer installation and are accessible for maintenance. Installation of the solenoid valves and the related electronics within an explosion-proof housing keeps the installation neat and safe.

The problems which must be solved in sample preparation are as varied as the installations of these instruments. The handling of corrosive as well as non-corrosive liquids and gases to obtain a representative sample stream taxes the ingenuity.

Presentation of Analysis

Sample-stream composition generally is recorded on a circular or strip-chart potentiometer-recorder located in the process control house. As most infrared-analyzer calibrations are far from straight lines, it is necessary to use either (1) a special chart and scale that is made to conform to the calibration curve, or (2) electronic circuits to linearize the record, or (3) calibration curves or tables. The latter is frequently done. If the instrument is used for automatic control, it is less important to have the analysis read directly because the object is steady operation at one preset level with only infrequent changes. If, however, the data is used for material-balance evaluation and product monitoring, it is important to have the calibration readily available or, better yet, to have a direct-reading recorder.

CHEMICAL PROCESSES

continued from page 779

supply is applied to the plant while it is under automatic control. Also assume that, following this disturbance, the control system goes into continuous oscillation and "hunts" steadily. *This could not occur in the absence of the controller.* If oscillations are set up in controlled condition, they must be caused and maintained by the controller.

If a detecting element is used both at the input and at the output of the process (as in Fig. 6-1), two curves will be produced, as in Fig. 6-2. However, it will now be found that the two curves are exactly 180 degrees out of phase, whereas the curves from the uncontrolled plant of Fig. 6-2 are not necessarily 180 degrees out of phase. The curves in Fig. 6-2 represent the effect of applying a continuous sinoidal disturbance to the plant (via the regulating unit) from an outside source while the plant is uncontrolled; the period of the disturbance can be varied as we please, with consequent variation of the attenuation and phase lag in the plant. However, when oscillation is produced by action of the controller on the regulating unit, the phase lag between the two signals in Fig. 6-2 *must* be 180 degrees. Let us examine how the oscillation is maintained.

Assume that the phase lag in Fig. 6-2 is 180 degrees and that the attenuation is A. If this is true, the disturbance at the output of the plant is 180 degrees out of phase with the disturbance at the input, and is smaller in amplitude by a factor A. If the output is fed to a controller (as in Fig. 6-8) with a gain of A, the output of the controller will be a signal that exactly equals the disturbance at the input of the plant. In addition, a controller always imposes a 180-degree change in phase in the signal. As the signal into the controller is already 180 degrees out of phase with

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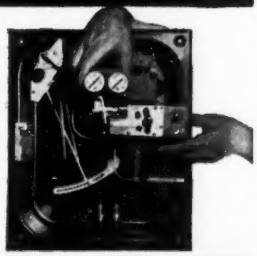

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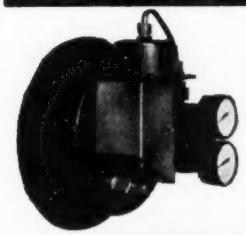

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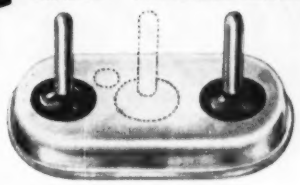

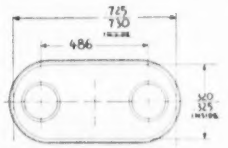

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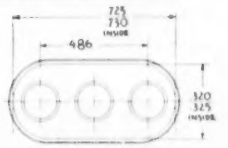

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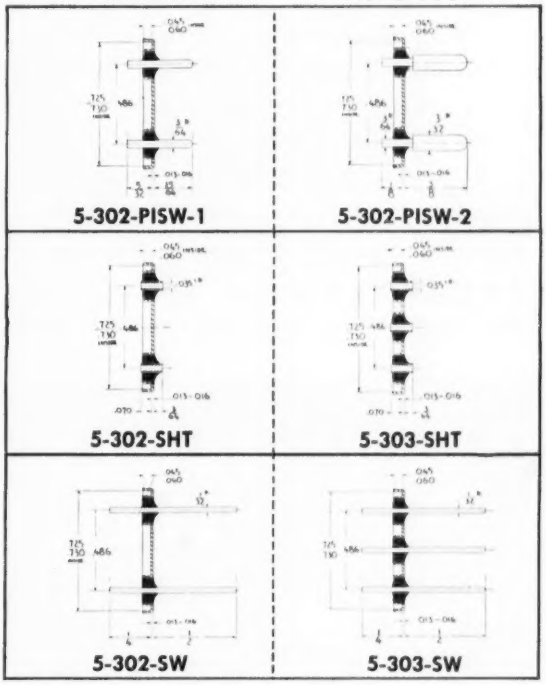

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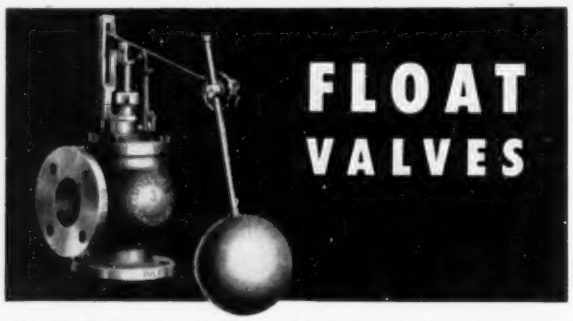

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the original disturbance at plant input, the controller adds another 180 degrees, thus producing a 360-degree phase shift. Hence the controller output will be a signal that exactly equals the original disturbance in both amplitude and phase. These are the conditions for sustained oscillation. If the controller in Fig. 6-8 is connected to the regulator under these conditions, the plant will oscillate, or hunt.

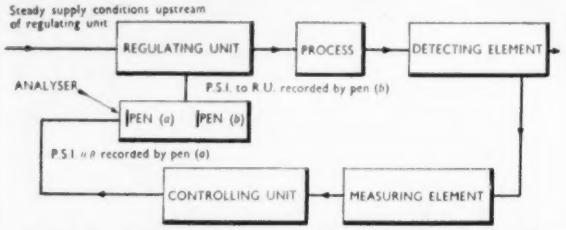

Fig. 6-8. Arrangement of plant and analyzer for obtaining plant characteristics. Pen (b) records sine-wave psi. from analyzer to regulator (or disturbance imposed on input to process); pen (a) records psi. from output of process, or disturbance after passage through plant. The controlling unit shown is used only as transmitter for recording disturbance at output of plant on analyzer chart; it is not controlling regulator.

It is clear that this cycle of events can only result in a steady, continuous oscillation if the controller gain is equal to A and if the disturbance takes one half the operating period to pass through the plant. Hence the controller gain must equal A. If it is greater, the amplitude of oscillation will build up. If it is less the amplitude will decrease and the oscillation will die out.

There is only one period of operation at which the phase lag in the plant is exactly 180 degrees, and therefore there is only one operating period at which the control system can "hunt" under proportional control. This period is called the *natural period* of the plant under control.

Controller Settings

Proportional Control

Let us now set up a proportional controller to control the plant whose characteristics are given by Figs. 6-3 and 6-4. The natural period of the plant, at which the phase lag suffered by any disturbance passing through the plant is 180 degrees, is given by point X on the curve in Fig. 6-3 as 15 minutes. Fig. 6-4 shows that at this period the corresponding attenuation (A) is 10. The maximum controller gain must therefore be 10 and by definition, for a proportional controller, controller gain = proportional control factor (μ). Therefore $\mu = 10$.

Determination of Proportional Band Width

Let us consider a temperature control system with air-operated controller and valve. The full working range of both is 12 psi. and the scale range of the measuring unit is 200 deg. C. It is required to set the proportional band so that the proportional control factor (μ) = 10.

The corrective action applied to the plant following a deviation of controlled condition from desired value is

$$\Theta = -\mu\,\theta$$

The proportional control factor $\mu = K_1 K_v$
where * $K_1 = V / \theta$, and $K_v = \Theta / V$

(K_1 is the proportional action factor, V is the change in controller output pressure in psi. corresponding to a change θ in deviation.)

To find K_v apply 1 psi. to the valve and note the change in temperature when conditions are again steady, say 5 C. deg. This is the potential correction (Θ / psi.) applied to the valve.

Then $K_v = 5$ C. deg. / psi.
Therefore $\mu = -K_1 \times 5$
Hence $K_1 = 10/5 = 2$ psi. / C. deg.

The proportional band must therefore be set so that the controller gives 2 psi. change in output to the valve for a deviation of 1 deg. C.

By definition, the proportional band is the percentage of the scale over which the pen must move to produce the full range of pressure to move the valve from open to shut

* It should be noted that for proportional control it is necessary to use a valve with a linear relation between Θ and V, as well as proportional action in the controller.

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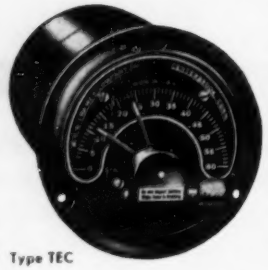

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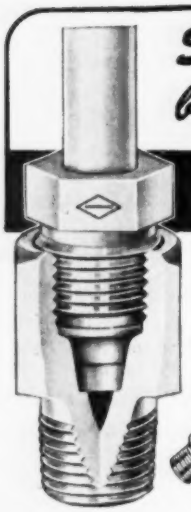

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position—i.e., 12 psi. The band must in this instance be $12/2 = 6$ C. deg., i.e. 3 percent of full scale.

Hence, in this example, for $\mu = 10$, the proportional band is 3 percent.

To find μ for Subsidence Ratio $e/1$

When steady hunting occurs on the plant, the proportional band is widened in order to damp the oscillation—i.e., μ is decreased.

To find the value of μ which will give a subsidence ratio of $e/1$, the phase lag/period curve in Fig. 6-3 must be corrected in order to permit the new value of μ to be read off from the corresponding attenuation/period curve. For most practical purposes, it is sufficient to add 10 percent to the ordinates in Fig. 6-3, provided that the lags in the plant are mainly transfer lags.*

Effect of the Location in the Plant of the Initial Disturbance

If the initial disturbance does not come into the plant at the regulating unit, but at a point nearer the measuring element, it will not be attenuated to the same degree in its shorter passage through the plant.** Hence, to obtain sustained hunting, the gain of the controller can be less and hence μ will be smaller.

It is important to emphasize this point because the deviation reduction factor is proportional to μ. Hence this factor, which determines the controllability of the system, will decrease as the location of the disturbance gets nearer the detecting element. The plant should therefore be designed so that disturbances do not occur after the main capacities in the plant. This is very important in practice.

Summary

(i) The objective in setting up a proportional controller is to obtain a rapid return of the controlled condition to the desired value after a disturbance has caused oscillations in the controlled condition.

(ii) As a first step towards determining the width of the proportional band of the controller which will achieve this objective, we have considered the conditions that exist when the system is in sustained oscillation. This corresponds to the action taken on the plant in setting up a controller; the setting for continuous oscillation or "hunting" is first determined.

(iii) The sustained oscillation will have a period such that the plant lag is 180 deg. This period is the *natural period* of the plant.

(iv) The proportional control factor (μ) must be set equal to the attenuation in the plant at the natural period.

(v) The proportional band width is inversely proportional to μ and can be found from it.

(vi) The value of the proportional factor which will give a "subsidence ratio" of $e/1$ is given by the frequency-response diagram, redrawn for damped conditions. This value must be used to find the proportional band width for this subsidence ratio.

(vii) If μ is small, the proportional band is wide and hence offset will occur if the load changes. Also, the deviation reduction factor is proportional to μ. Therefore, in order both to keep offset small and the peak deviation small, μ must be made as large as possible.

(viii) The maximum value of μ which can be used is limited by the attenuation in the plant at the natural period. If this is small, μ will be small and offset will occur. If the offset is too great to be acceptable, it must be limited by adding another action to the controller.

(ix) A disturbance entering the plant between a major plant capacity and the controller will lead to a reduction in controllability.

To be continued

* For a discussion of the limitations of this method and an exact general treatment see "Theoretical Basis of Graphical Frequency Response Analysis", N. Ream, to be published in Trans. S. I. T.

** Nearness to the detecting element in this sense indicates the proportion of the plant capacity the disturbance has to go through before reaching the measuring element.

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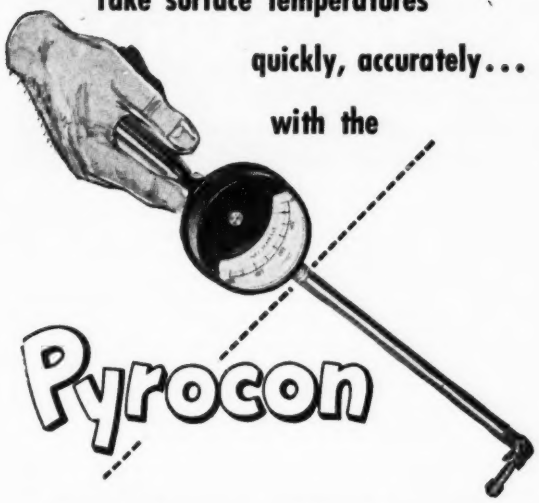

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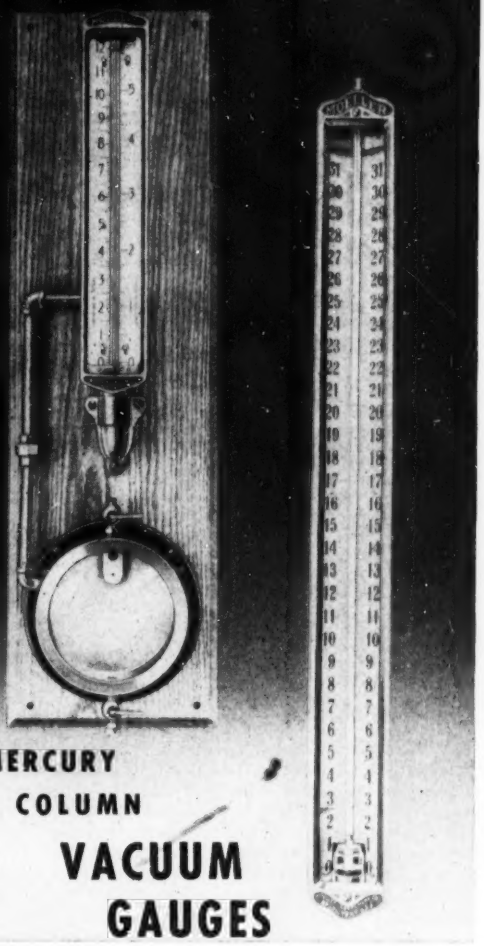

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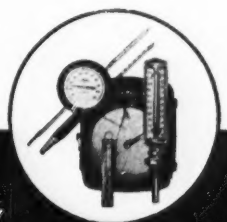

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INSTRUMENTS ON THE MARCH

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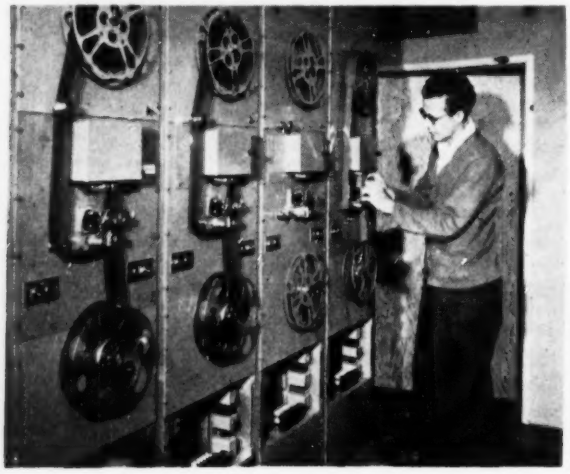
Radioactive Tracer Aids Communication

NIAGARA FALLS, N. Y.—A $0.60 drop of radioactive cobalt is playing an important role in The Carborundum Company's internal communication system. The cobalt, which is fastened permanently to the metal mailing carriers

that service the Company's 40-acre plant and executive offices in Niagara Falls, New York, is easily detected by a Geiger counter—and thus has reduced delay in locating jammed mail carriers in the pneumatic-tube mailing system. A Tracerlab Geiger counter is shown being used to quickly locate a defect in the 8000 feet of tubing. Each of the company's 200 mail carriers are tagged with the radioactive cobalt—all obtained from the single $0.60 drop of radioactive cobalt.

Magnetic Recording

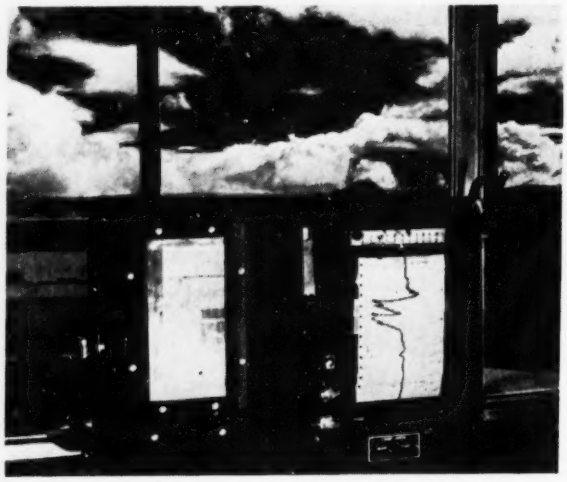
HOLLYWOOD, CALIF.—What is said to be the largest independent installation of magnetic recording on the west



coast, at Film Recorders in Hollywood, has been made by Cinema Engineering Co., Burbank. Remote and inter-locking systems provide a close tie-in between Film Recorders and the film-producing Telepix Corp. in adjacent facilities. Facilities include transfer facilities for 16- and 35-mm. photographic film and 17½- and 35-mm. magnetic film.

Weather Recorder

SCHENECTADY, N. Y.—A pen that writes the weather for General Electric Research Laboratory scientists has indicated the approach and passage of a line squall by inscribing a jagged pattern on a chart. Approach of the storm built up a negative electric potential on an antenna outside



the penthouse weather station. This potential moved the pen of the GE photoelectric recorder to the left of center on the lower portion of the chart (first approach of the storm) despite blue skies and fleecy clouds outside. As the squall drew nearer, the leftward movement of the pen increased. Radium-impregnated gold foil is placed on the antenna point to make it sensitive to atmospheric conditions.

Tachometer Aids in Surveying

HOUSTON, TEXAS.—A General Electric tachometer generator used in conjunction with electronic equipment is aiding the Schlumberger Well Surveying Corporation of Houston, Texas in accurate recording of the characteristics of sub-surface geological formations encountered in oil-well drilling. The instrument enables well surveyors to read and maintain a uniform speed while lowering or withdrawing instrument-bearing cables in the drill holes.

The many services of the corporation include the recording of electrical resistivity, potential, and radioactive characteristics of sub-surface formations—often at a depth of two or three miles below the surface. It is important to maintain a fixed and constant speed. The tachometer solves the problem.

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Manufacturers' New Literature

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 929.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

TEMPERATURE

Radiation Detectors. New 4-page Specification Sheet 84 illustrates and describes maker's "Radiamatic" compensated radiation detectors for pyrometry. Includes general-purpose, small-target, miniature, and low-range models.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle 401 on inquiry card.

Recording Alarm Thermometer. New 4-page Bulletin T853 describes and illustrates maker's recording alarm thermometer for use in blood banks, etc.—The Bristol Co., Waterbury 20, Conn.

Circle 402 on inquiry card.

Temperature Controller. New 4-page Bulletin F 5783 describes and illustrates maker's line of "Model 200 Series Capacitrols" with "Capaciline" anticipatory response for straight-line temperature control. Includes diagrams and specifications.—Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Circle 403 on inquiry card.

Dial Thermometer. New 4-page Bulletin 3 describes and illustrates maker's stainless-steel bimetal-actuated dial-indicator thermometer.—W. C. Dillon Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle 404 on inquiry card.

Thermocouples, Ovens. New 4-page bulletin describes and illustrates maker's thermocouple heads, lead wire and tubes, foundry-sand controllers, and industrial furnaces and ovens.—Claud S. Gorden Co., 3000 S. Wallace St., Chicago 16, Ill.

Circle 405 on inquiry card.

Window Thermometers. New 2-page illustrated Brochure A-38 presents features and operation of maker's "Remo-Set" maximum-minimum dial window thermometers. Also described is desk thermometer-hygrometer.—Taylor Instrument Companies, Rochester 1, N. Y.

Circle 406 on inquiry card.

PRESSURE

Pressure Gages. New 4-page price list gives prices for maker's large line of gages and accessories.—Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.

Circle 407 on inquiry card.

Mechanical Pressure Gage. New 4-page Bulletin PG-2 describes and illustrates maker's mechanical pressure gage for pressure or compressive loads.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle 408 on inquiry card.

Mach Meter. New 4-page bulletin illustrates and describes maker's mach meter for measuring compressibility effects for diving airplanes and wind-tunnel tests. Includes characteristics and principles of operation.—Taller & Cooper, 75 Front St., Brooklyn, N.Y.

Circle 409 on inquiry card.

Baroresistor. New 4-page illustrated bulletin describes and gives uses of maker's "Type 71-5 Baroresistor", a sealed pressure-operated potentiometer which operates linearly as a function of absolute pressure over barometric range.—Bedford Airport, Bedford, Mass.

Circle 410 on inquiry card.

Gage Protectors. New catalog describes and illustrates maker's pressure-gage protectors and snubbers.—Republic Manufacturing Co., 1930 W. 77th St., Cleveland 2, Ohio.

Circle 411 on inquiry card.

Packing, Sealing Compound. New 2-page bulletin describes and illustrates maker's "Molyseal", self-sealing and packing compound for steam, water, compressed-air applications, expansion joints and pumps, valve packing, etc.—Surveys, Inc., 219 Euclid Ave., Trenton 9, N.J.

Circle 412 on inquiry card.

Pilot-operated Pressure Regulator. New 4-page Bulletin 614 describes and illustrates maker's twin-nozzle pilot regulator that controls pressures from ounces to 1,000 psi. Includes dimensions and mention of other products.—Wilgus Manufacturing Co., 1722 E. 16th St., Los Angeles 21, Calif.

Circle 413 on inquiry card.

Barometers. New 8-page Folder A-15 illustrates and describes maker's large line of ship, home, and office "Baroguide" barometers with forecast dial. Includes more than 30 models.—Taylor Instrument Companies, Rochester 1, N. Y.

Circle 414 on inquiry card.

WEIGHT

Electronic Scale, Printer. New set of brochures present features and specifications of maker's electronic scale and printer for on-the-job measurement and indication-printing of weight, force, torque, or strain.—Gilmore Industries, 5511 Euclid Ave., Cleveland 3, Ohio.

Circle 415 on inquiry card.

Weight Indicator. New 6-page illustrated Bulletin W-1 presents fea-

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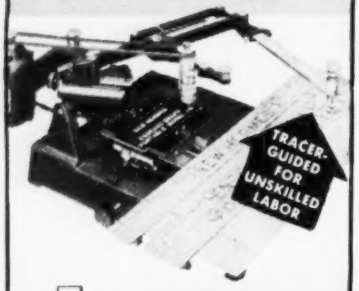

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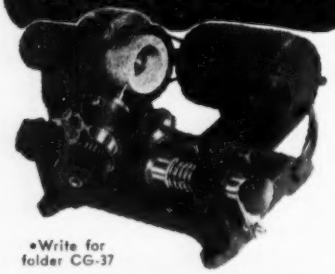

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For more information circle 121 on inquiry card.

tures, specifications, and applications of maker's industrial weight indicator. —W. C. Dillon & Co., 14620 Keswick St., Van Nuys, Calif.

Circle 416 on inquiry card.

Weight Printer. New 2-page bulletin describes and illustrates maker's electric indicator and printer for printing force or weight on tape or card.—Gilmore Technical Associates, 5511 Euclid Ave., Cleveland 3, Ohio.

Circle 417 on inquiry card.

Scale Seal. New 2-page bulletin describes and illustrates maker's liquid seal for sealing weight tables on all scales.—Applied Engineering Co., Orangeburg, South Carolina.

Circle 418 on inquiry card.

PROCESS CONTROL

Industrial Controls. New 84-page illustrated Catalog 8305 presents features, operation, and applications of maker's non-indicating electric, electronic, and pneumatic controllers for temperature, pressure, humidity, etc. Includes relays, contactors, valves, switches, motorized valves, etc.—Minneapolis-Honeywell Regulator Co., Sta. 64, Industrial Div., Phila. 44, Pa.

Circle 419 on inquiry card.

Industrial Instrumentation. New 16-page Bulletin 18 describes and illustrates maker's indicators, recorders, and controllers for measurement, transmission, and control in power plants and industrial processes.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle 420 on inquiry card.

Electric Controls. New 4-page bulletin describes and illustrates maker's types of electric controls for industrial, marine, military, and power-plant applications including switchgear, generator control, industrial process control, etc.—Lake Shore Electric, Inc., 239 Willis St., Bedford, Ohio.

Circle 421 on inquiry card.

MOISTURE

Moisture Tester. New 4-page bulletin (data file 307-47) describes and illustrates maker's "Aquameter" which titrates for moisture automatically.—Beckman Instruments, Inc., South Pasadena 1, Calif.

Circle 422 on inquiry card.

Moisture Register. New 4-page bulletin describes and illustrates maker's "G-5" electronic moisture register for granular, ground, loose, shredded and powdered materials.—Moisture Register Co., 1510 W. Chestnut St., Alhambra, Calif.

Circle 423 on inquiry card.

LABORATORY APPARATUS

Laboratory Apparatus. New 22-page illustrated brochure "A Catalog of Laboratory Specialties" presents features and specifications of maker's stirrers, paddles, electronic relays, shakers, and particle-size apparatus. —Palo Laboratory Supplies, 81 Reade St., New York 7, N. Y.

Circle 424 on inquiry card.

Laboratory Apparatus. Four new 4-page illustrated brochures present features and operation of maker's laboratory apparatus. Bulletin 328 covers gas analyzers plus furnaces and other apparatus. Bulletin 319 covers "Combustion" for carbon-by-combustion. Bulletin 323 covers "Carbotrane" for gravimetric determinations of carbons-by-combustion. Bulletin 327 covers gas-analysis solutions for CO, O_2, illuminants, CO_2, etc.—Burrell Corp., 2223 Fifth Ave., Pgh. 19, Pa.

Circle 425 on inquiry card.

Laboratory Apparatus. New 20-page June issue of "C A Notebook" describes and illustrates maker's Warburg apparatus, capillary manometers, reaction vessels, glassware washers, plastic pipe fittings, etc.—Chicago Apparatus Co., Chicago 22, Ill.

Circle 426 on inquiry card.

Laboratory Apparatus. New 32-page No.-15 issue of "Scientific Apparatus and Methods" features articles on new oscillometric accessories and gas-analysis apparatus. Includes specifications on projection balances, combustion apparatus, cloud and pour test apparatus, etc.—E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.

Circle 427 on inquiry card.

Laboratory Apparatus. New 4-page Bulletin 328 describes and illustrates maker's scientific apparatus and laboratory chemicals, including gas analysts, furnaces, "Combustron," "Carbotrane," shakers, etc.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle 428 on inquiry card.

Oxidation Unit. New 2-page bulletin describes and illustrates maker's "Model A" JRS oxidation unit for determination of oxygen absorbed by materials subject to deterioration by air.—G. F. Bush Associates, Princeton, N. J.

Circle 429 on inquiry card.

Laboratory Filter. New 6-page folder describes and illustrates maker's filter with porous stainless-steel filter element. Also other laboratory apparatus.—Micro Metallic Corp., Glen Cove, N.Y.

Circle 430 on inquiry card.

Chemical Control, Reagents. New 54-page General Catalog presents maker's large line of instruments and reagents for pH, chlorine control, soil testing, water analysis, electroplating baths, and vitamin studies.—LaMotte Chemical Products Co., Towson, Baltimore 4, Md.

Circle 431 on inquiry card.

Constant-temperature Bath. New 4-page bulletin describes and illustrates maker's constant-temperature bath that permits parts to be micrometered at same temperature.—Service Metal Fabricators, 350 N. Foothill Rd., Beverly Hills, Calif.

Circle 432 on inquiry card.

Incubators. New 8-page Catalog 100, Sec. 2, gives details, illustrations, and prices of maker's large line of incubators, paraffin ovens, and room incubators.—Chicago Surgical & Electrical Co., 217 N. Desplaines St., Chicago 6, Ill.

Circle 433 on inquiry card.

ANALYTICAL

Grating Spectrographs. New 16-page Catalog G2-53 illustrates and describes maker's grating spectrographs. Also available are leaflets on "Visual Lines for Spectroscopic Analysis" and "Metal Spectroscopy."—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.
Circle **434** on inquiry card.

Recording Microphotometer. New 4-page Data Sheet 10.16-16 describes "Jaco" recording microphotometer used with maker's "ElectroniK" recorder. Includes design features and operation.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.
Circle **435** on inquiry card.

Spectrophotometer. New 4-page report DU-18-F stresses analytical uses of spectrophotometer in food process control. Typical problems and solutions are given.—Beckman Instruments, Inc., S. Pasadena, Calif.
Circle **436** on inquiry card.

Color Comparators. New 12-page Bulletin GF-11 presents maker's line of slide comparators for pH, phosphate, chlorine, and water analysis. Also described are titration sets, chlorimeters, etc.—W. A. Taylor & Co., 7300 York Rd., Baltimore 4, Md.
Circle **437** on inquiry card.

Viscometers. New 2-page Bulletin V1210-A illustrates and describes maker's viscometers for recording or recording-controlling of viscosity in industrial plants.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.
Circle **438** on inquiry card.

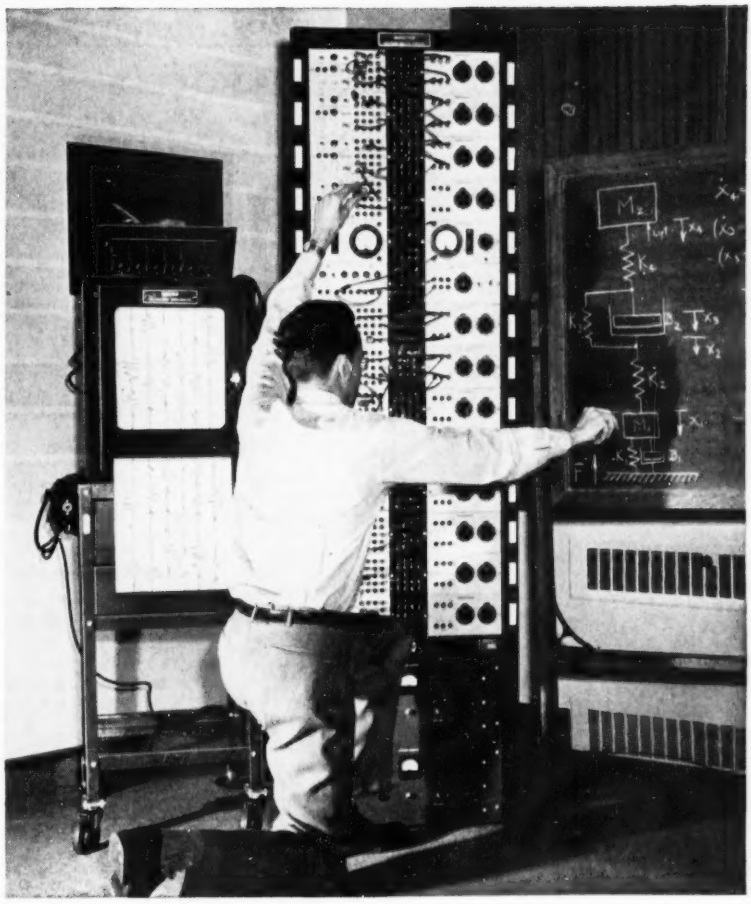
CO Detector. New 12-page Bulletin 201 describes and illustrates maker's carbon monoxide detector for protection wherever carbon monoxide threatens. Includes operation and specifications.—Taller & Cooper, 75 Front St., Brooklyn 1, N. Y.
Circle **439** on inquiry card.

Warburg Apparatus. New 6-page bulletin describes and illustrates maker's Warburg apparatus for microgas analysis, with and without fluorescent tubes for photosynthesis.—Bronwill Scientific, Inc., 40 Worth St., New York 13, N.Y.
Circle **440** on inquiry card.

Refractometer. New 2-page bulletin describes and illustrates O.P.L. French-made refractometer for fruit juices, etc.—E. J. Van Der Leur, 60 Beaver St., New York 4, N.Y.
Circle **441** on inquiry card.

Infrared Absorption Cells. New 2-page Bulletin 3-A describes and illustrates maker's ten types of infrared absorption-cell accessories for spectrometers.—The Perkin-Elmer Corp., Norwalk, Conn.
Circle **442** on inquiry card.

Spectroscopic Excitation Unit. New 4-page bulletin illustrates and describes maker's "Varisource," an all-in-one excitation unit for precision spectrochemical analysis used in handling samples submitted for spectrochemical analysis in solid, powder, or liquid form. Includes specifications, dimensions, weights, requirements.—Jarrell-Ash Co., 165 Newbury St., Boston 16, Mass.
Circle **443** on inquiry card.



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For more information circle **125** on inquiry card.

PHOTO-COPYING

Photo-copier. New 4-page illustrated brochure presents features, operation, and applications of maker's "Contoura" photo-copier for rapid reproduction of any page, document, etc.—F. G. Ludwig Associates, Deep River, Conn.

Circle **444** on inquiry card.

Photocopying. New 12-page booklet tells advantages and features of maker's "Apeco Auto-Stat" photocopying equipment.—American Photocopy Equipment Co., 2849 N. Clark St., Chicago 14, Ill.

Circle **445** on inquiry card.

PHOTOELECTRIC

Photoelectric Reflection Meter. New 10-page Bulletin 605 illustrates and gives thorough description of maker's "Model 610" photoelectric reflection meter for measuring whiteness.—Photovolt Corp., 95 Madison Ave., New York 16, N.Y.

Circle **446** on inquiry card.

Turbidity Instruments. New 2-page Bulletin 531 illustrates and describes maker's turbidity instruments—indicators and recorders. Includes specifications.—Ess Instrument Co., 96 S. Washington Ave., Bergenfield, N. J.

Circle **447** on inquiry card.

Photoelectric, pH Instruments. New 4-page Bulletin 100 describes and illustrates maker's photoelectric instruments, including colorimeters, densitometers, photometers, and reflection meters. Also described are pH meters. —Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

Circle **448** on inquiry card.

OPTICAL

Surveying. New 20-page "Surveyor's Notebook" No. 2 relates several interesting experiences of surveyors and describes maker's surveying equipment.—W. & L. E. Gurley, Troy, N.Y.

Circle **449** on inquiry card.

Optical Tooling. New 30-page Bulletin 808 Sup. 1. 3-53 illustrates maker's optical tooling instruments for aircraft. Includes alignment telescope, optical square, magnetic collimating mirror, adjustable telescope bracket, etc.—Farrand Optical Co., Inc., Bronx Blvd. & E. 238 St., New York 10, N.Y.

Circle **450** on inquiry card.

Microscope. New 2-page bulletin describes and illustrates maker's "Reichert Universal Camera Microscope Model MeF".—William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N.Y.

Circle **451** on inquiry card.

Interference Microscope. New 12-page bulletin describes and illustrates advantages of maker's interference microscope, including principles, features, construction, and uses for surface testing, etc.—Carl Zeiss, Inc., 485 5th Ave., New York 17, N.Y.

Circle **452** on inquiry card.

Optical Instruments. New 12-page circular illustrates and describes maker's pocket comparator for inspection, telescopes, microscopes, astronomical mirror mounts, first-surface mirrors, reticles, projector-viewers, hand spectroscopes, etc.—Edmund Scientific Corp., 101 E. Gloucester Pike, Barrington, N. J.

Circle **453** on inquiry card.

Optical, Electronic Instruments. New 4-page illustrated bulletin presents maker's monochromators, fluorometers, interference filters, photometers, thermocouples, electron microscopes, optical tooling instruments, amplifiers, and ratio comparators.—Farrand Optical Co., Bronx Blvd. & E. 238 St., New York 70, N. Y.

Circle **454** on inquiry card.

Machine-tool Microscope. New 2-page Product Bulletin 0-2 illustrates and describes maker's "Model 11" machine-tool microscope for application in machine shop.—Perkin-Elmer Corp., Norwalk, Conn.

Circle **455** on inquiry card.

TESTING & INSPECTION

Torque Testers. New 4-page bulletin describes and illustrates maker's universal and special torque-testing fixtures for threads, screws, inspection, etc. Includes hair-spring torsion tester.—P. A. Sturtevant Co., Addison, Ill.

Circle **456** on inquiry card.

Balancing Machines. New 2-page bulletin describes and illustrates maker's static precision production balancing machines.—Micro-Poise Engineering & Sales Co., 14851 Grand River Ave., Detroit 27, Mich.

Circle **457** on inquiry card.

Gages. New 8-page Bulletin 53A describes, illustrates, and prices maker's gages for dimensional control of internal "O-ring" grooves.—Reliant Industries, 4947 Firestone Blvd., South Gate, Calif.

Circle **458** on inquiry card.

Magnetic Inspection Equipment. New 4-page Bulletin 60 describes and illustrates maker's magnetic analysis multi-method equipment, magnetic analysis comparators, and magnetic analysis demagnetizers.—Magnetic Analysis Corp., 511 Fifth Ave., New York 17, N.Y.

Circle **459** on inquiry card.

Magnetic Comparators. New 4-page Bulletin 30 describes and illustrates maker's magnetic analysis comparators for inspecting ferrous and nonferrous materials or parts.—Magnetic Analysis Corp., 511 Fifth Ave., New York 17, N. Y.

Circle **460** on inquiry card.

Inspection Projectors. New 4-page leaflet CTOO describes and illustrates English-made Hilger comparator projectors for gaging and inspection. Includes features.—Engis Equipment Co., 431 S. Dearborn St., Chicago, Ill.

Circle **461** on inquiry card.

Stopwatch. New 6-page Booklet C-47 describes and illustrates maker's stopwatches.—Clebar Watch Agency, 521 Fifth Ave., New York 17, N. Y.

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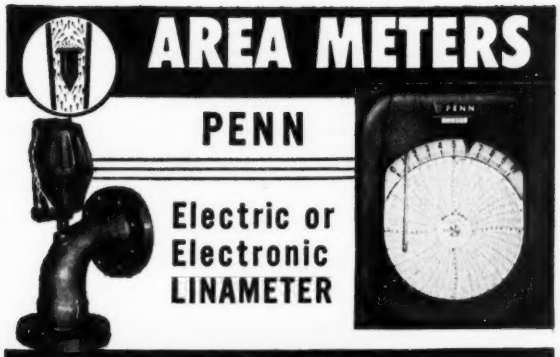

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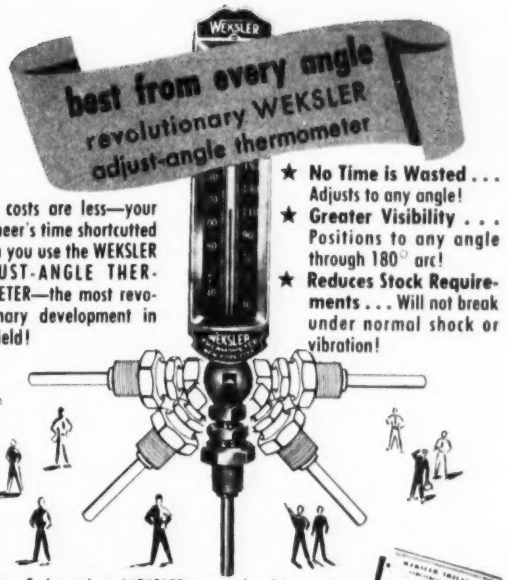
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Spot Illuminators. New 4-page Booklet H2-52 describes and illustrates maker's "Handylites", electrically illuminated diagnostic instruments with magnifying lens for exploring obscure areas.—Welch Allyn, Skaneateles Falls, N.Y.
Circle **463** on inquiry card.

Hydrostatic Testing Machines. New 4-page brochure illustrates and describes maker's hydrostatic testing machines for pressure-testing parts on production-line basis. Includes specifications.—Steel City Testing Machines, Inc., 8817 Lyndon Ave., Detroit 21, Mich.
Circle **464** on inquiry card.

Tensile Testing Machine. New 4-page Bulletin C.T. 1-5 describes and illustrates maker's motor-driven hydraulic tensile testing machine for production testing, laboratory work, and quality control.—Cal-Testing Machine Co., Los Angeles 34, Calif.
Circle **465** on inquiry card.

Impact Tester. New 2-page Bulletin 787 illustrates and describes maker's SPI low-temperature impact tester.—U. S. Testing Co., Hoboken, N. J.
Circle **466** on inquiry card.

TEST CHAMBERS

Altitude Chambers. New 4-page Bulletin 9081 describes and illustrates maker's standard line of "Tenneyzphere" altitude chambers. Includes performance data, specifications, and chamber construction information.—Tenney Engineering Inc., 26 Avenue B, Newark 5, N.J.
Circle **467** on inquiry card.

Test Chambers. New 4-page bulletin describes and illustrates maker's environmental test chambers, and gives information on custom-built facilities.—American Research Corp., Bristol, Conn.
Circle **468** on inquiry card.

RECORDING

Direct-writing Recorders. New 16-page bulletin describes and illustrates advantages of maker's direct-writing recorders for industrial uses—strain, vibration, pressure, current, etc.—Sanborn Co., Cambridge 39, Mass.
Circle **469** on inquiry card.

Recording, Telemetering, Mass Spectrometry. New 12-page issue Vol. 7 No. 1 of "CEC Recordings" includes 9 articles on modern instrumentation—mass spectrometry, missile telemetering, impact recording, etc.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.
Circle **470** on inquiry card.

Oscillograph Recording. New 12-page issue of the Hathaway "Engineering News", Vol. 3 No. 1, features articles on bifilar oscillograph galvanometers, Watt galvanometers, and the measurement of strain.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Circle **471** on inquiry card.

Oscillograph Recorder. New 4-page illustrated bulletin describes maker's "Model 560" oscillograph that records under extreme shock conditions.—Midwestern Geophysical Laboratory, 3401 S. Harvard Ave., Tulsa, Oklahoma.
Circle **472** on inquiry card.

Half-second Potentiometer Recorder. New 2-page "Instrumentation Data Sheet 10.0-13 describes and illustrates maker's half-second "Electronik" recorder for rapidly changing variables.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.
Circle **473** on inquiry card.

Record-Reproduce and Erase Heads. New Catalog Sheet ME 12001 illustrates and describes maker's new record-reproduce and erase heads for use in magnetic recording. Includes operating data and dimensions.—Brush Electronic Co., 3405 Perkins Ave., Cleveland 14, Ohio.
Circle **474** on inquiry card.

Data Recorder, Annunciator. New 12-page Power Control Bulletin 101 illustrates and describes maker's sequential automatic data recorder and annunciator for industrial plants and power systems. Includes engineering data, uses, and applications.—Taller & Cooper, 75 Front St., Brooklyn 1, N.Y.
Circle **475** on inquiry card.

Automatic Typewriter. New 4-page illustrated Bulletin SP-8559R presents features, operation, and applications of maker's "Justowriter" automatic composing typewriter that uses coded tape to automatically retype and justify copy for composition work. New 4-

page Bulletin SP-8567R presents "Flexowriter" that uses the coded tape to automatically emboss Addressograph plates.—Commercial Controls Corp., Rochester 2, N. Y.
Circle 476 on inquiry card.

Automatic Typewriter. New 6-page bulletin describes and illustrates maker's coded-tape-operated automatic "Flexowriter" typewriter that types repetitive information automatically. —Commercial Controls Corp., One Leighton Ave., Rochester 2, N.Y.
Circle 477 on inquiry card.

High-speed Potentiometer Recorder. New 12-page illustrated Bulletin C-39-0 presents features, principles, and performance of maker's 20-channel 1/20-sec.-per-reading potentiometer recorder that uses dot-digit system of recording.—Ralph M. Parsons Co., 617 S. Olive Ave., Los Angeles 13, Calif.
Circle 478 on inquiry card.

Multi-channel Recording. New 24-page bulletin describes and illustrates maker's "Model BP-2" 15-channel miniature balance-panel for multiple-channel data recording, as in flight-test instrumentation.—American Helicopter Co., Inc., 1800 Rosecrans Ave., Manhattan Beach, Calif.
Circle 479 on inquiry card.

RADIOACTIVITY

Nucleonic Instruments. New 40-page Catalog 14M-353 describes and illustrates maker's scaling units, counting systems, area monitors, portable survey instruments, timers, cables, etc.—Nuclear Instrument & Chemical Corp., 223 W. Erie S., Chicago 10, Ill.
Circle 480 on inquiry card.

Radioactivity. New 16-page bulletin presents maker's design and technical specifications on boron trifluoride counters, flow counters, linear amplifiers, scalers, nucleometer, and radiation safety devices.—Radiation Counter Laboratories, Inc., 5122 W. Grove St., Skokie, Ill.
Circle 481 on inquiry card.

Pocket Dosimeters. New 2-page Bulletin 106A illustrates and describes maker's self-reading pocket dosimeters and "Model 103A" charging unit. Includes features, specifications.—Arnold O. Beckman Inc., 1020 Mission St., South Pasadena, Calif.
Circle 482 on inquiry card.

Scintillation, Geiger Counting. New 8-page bulletin describes and illustrates maker's scintillation and geiger counting instruments.—R-C Scientific Instrument Co., Inc., 335 Culver Blvd., Playa Del Rey, Calif.
Circle 483 on inquiry card.

Nucleonic Scaler. New 2-page bulletin illustrates and describes maker's "Model A-63" automatic scaler.—Atomlab Inc., 489 Fifth Ave., New York 17, N.Y.
Circle 484 on inquiry card.

COUNTING, COMPUTING

Oscillograph-data Analyzer. New 2-page Instrumentation Data Sheet 10.0-11 describes new technique for rapid analysis of oscillographic analog-type data by use of "Telereader," proportioning system, and "Electronik" potentiometer.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.
Circle 485 on inquiry card.

Digital Converter. New 4-page illustrated bulletin describes maker's non-pulsing digital converter for converting analog output data (from potentiometer, etc.) into digital form. Includes operation, specifications.—Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N.Y.
Circle 486 on inquiry card.

Scaling, Timing. New 4-page illustrated bulletin gives descriptions and specifications of maker's scalers, totalizing units, time interval meters, and frequency measurement units.—Detectron Co., 5420 Vineland Ave., Hollywood, Calif.
Circle 487 on inquiry card.

Electronic Counter. New 4-page bulletin describes and illustrates maker's "Deci-tron" industrial electronic counter.—Post Machinery Co., 144 Elliot St., Beverly, Mass.
Circle 488 on inquiry card.

ACCELERATION, MOTION

Accelerometers. New 4-page bulletin describes and illustrates maker's self-generating accelerometers.—Gulton Mfg. Corp., Metuchen, N.J.
Circle 489 on inquiry card.

Electronic Tachometer. New 4-page Bulletin 200 describes and illustrates maker's electronic tachometer for rapid and precise measurement of speed, frequency, or pulses at frequencies up to 100,000 per second. Includes principles, diagrams, and specifications.—Standard Electric Time Co., Springfield, Mass.
Circle 490 on inquiry card.

Hand-Vibrograph. New 2-page bulletin describes and illustrates maker's hand-vibrograph for measurement and recording of vibrations.—Askania-Werke Ag., European Products Importing Co., Inc., 154 Nassau St., New York 38, N.Y.
Circle 491 on inquiry card.

Brake Testing Recorder. New 2-page bulletin describes and illustrates maker's "Decelerograph", brake-testing recorder and accelerometer.—Askania-Werke Ag., European Products Importing Co., Inc., 154 Nassau St., New York 38, N.Y.
Circle 492 on inquiry card.

AUDIO, RADIO EQUIPMENT

Audio, Radio Equipment. New 48-page Catalog Supplement 134 describes, illustrates, and prices distributor's audio and radio equipment and components. Includes industrial and service test units.—Allied Radio, 833 W. Jackson Blvd., Chicago 7, Ill.
Circle 493 on inquiry card.

Telemetering Instrumentation. New 2-page illustrated Bulletin B10 presents features, characteristics, and operation of maker's "Model 2540 Telemetering Commutator Simulator" for testing telemetering equipment.—Ralph M. Parsons Co., 135 W. Dayton St., Pasadena 2, Calif.
Circle 494 on inquiry card.

VHF Frequency Meter. New 4-page bulletin and 2-page list of users illustrate and describe maker's "Model FM-3" direct-reading VHF frequency meter for 20 to 640 Mc.—Gertsch Products, Inc., 11846-48 Mississippi Ave., Los Angeles 25, Calif.
Circle 495 on inquiry card.

Program Equalizer. New 2-page Bulletin C-1022 describes and illustrates maker's "Type 4031-B" program equalizer for sound and electronic laboratories.—Cinema Engineering Co., 1510 W. Verdugo Ave., Burbank, Calif.
Circle 496 on inquiry card.

Electronic Kits. New 4-page bulletin and 2-page insert describe and illustrate maker's kits for audio, video, and amplifier instruments. Includes information on transformers and resistors.—Heath Co., Benton Harbor, Mich.
Circle 497 on inquiry card.

Transfer Circuits. New 12-page issue Vol. 2 No. 4 of "Lenkurt Demodulator" features article on circuits for automatic transfer of point-to-point radio equipment in event of equipment failure.—Lenkurt Electric Co., San Carlos, Calif.
Circle 498 on inquiry card.

Carrier-system Levels. New 8-page Vol. 2 No. 5 issue of "The Lenkurt Demodulator" discusses factors affecting levels in carrier terminals.—Lenkurt Electric Co., San Carlos, Calif.
Circle 499 on inquiry card.

RF Attenuation Filters. New 12-page Catalog NB-148 describes and illustrates portion of maker's large line of "Quietone" filters for radio-frequency attenuation in electronic and electrical equipment.—Cornell-Dubilier Electric Corp., South Plainfield, N. J.
Circle 500 on inquiry card.

Message Repeater. New brochure presents features and specifications of new "Magneloop" endless-magnetic-tape recorder for intermittent or continuous message announcement.—Amplifier Corp. of America, 398 Broadway, New York, N. Y.
Circle 501 on inquiry card.

ELECTRICAL & ELECTRONIC INSTRUMENTS

Magnetic Amplifiers. New 8-page illustrated Bulletin GEA-5950 presents features, principles, operation, and specifications for maker's "Amplistat" self-saturating magnetic amplifiers for high-gain d-c. amplification. —General Electric, Schenectady 5, N. Y.
Circle 502 on inquiry card.

Electrical Indicating Instruments. New 32-page bulletin describes and illustrates maker's ruggedized, hermetically sealed, and standard electrical permanent-magnet moving-coil indicators. Also described are null indicators, direct-reading fluxmeter, meter tester, elapsed-time indicators, and induction soldering unit.—Marion Electrical Instrument Co., Manchester, New Hampshire.
Circle 503 on inquiry card.

Variable High- and Low-pass Filter. New 2-page Bulletin C-1021 describes and illustrates maker's "Type 6517-D" high- and low-pass filter.—Cinema Engineering Co., 1510 W. Verdugo Ave., Burbank, Calif.
Circle 504 on inquiry card.

Electrostatic Neutralizer. New 8-page Bulletin 125 describes and illus-

trates maker's "Magic Wand" electrostatic neutralizer that uses induction principle. Includes applications.—Herman H. Sticht Co., Inc., 27 Park Place, New York 17, N.Y.
Circle 505 on inquiry card.

Groundometers. New 4-page Bulletin 171 describes, illustrates, and gives uses of maker's "Type W4 Groundometer" for measurement of low-resistance ground paths.—Borden Engineering Co., New Providence, N. J.
Circle 506 on inquiry card.

Galvanometers. New 2-page Bulletin 300 describes and illustrates maker's "Type W" DC galvanometer with two ranges—5-0-5 volts and 25-0-25 microamps.—Borden Engineering Co., New Providence, N. J.
Circle 507 on inquiry card.

Electronic Test Equipment. New 12-page brochure describes and illustrates maker's line of electronic test equipment—low-frequency "Q" indicator, incremental inductance bridge, power supplies, megohmeter, etc.—Freed Transformer, Co., Inc., 1718-36 Weirfield St., Brooklyn 27, N.Y.
Circle 508 on inquiry card.

Decade Amplifier. New 2-page Bulletin 3-53 describes and illustrates maker's decade amplifier with gains of 40, 60, and 80 db. Also describes and illustrates maker's plug-in amplifier system.—Kalbfell Laboratories, Inc., 1090 Morena Blvd., San Diego 10, Calif.
Circle 509 on inquiry card.

Electrical Instruments. New 20-page 50th-Anniversary brochure describes company development, facilities, outlook, and products (circuit breakers, switchgear, watthour meters, etc.).—Roller-Smith Corp., Bethlehem, Pa.
Circle 510 on inquiry card.

POWER SUPPLIES

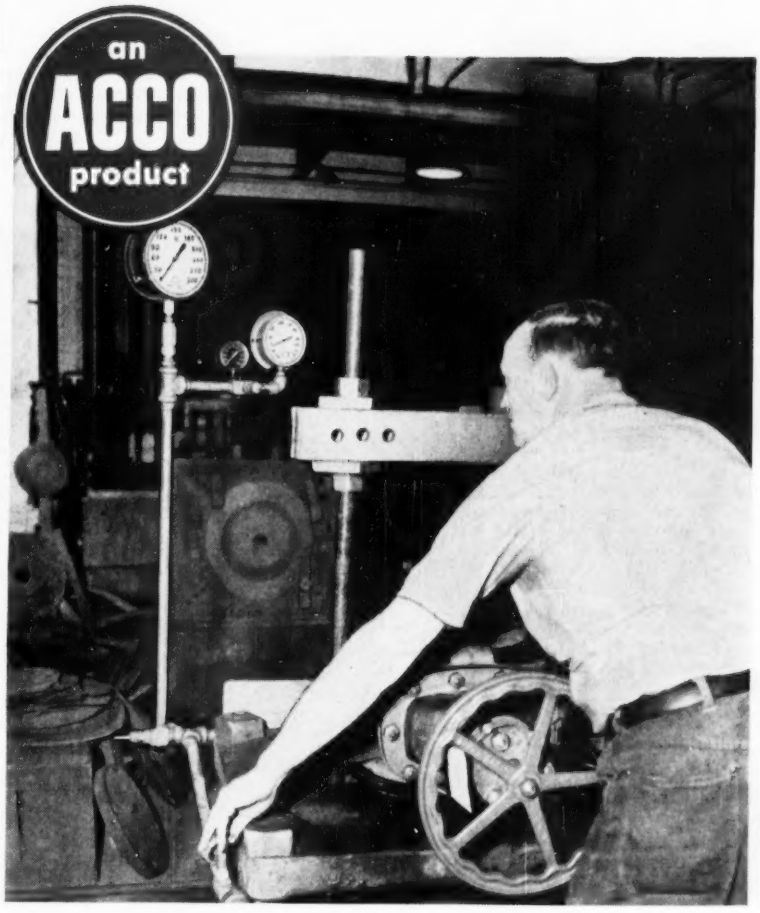
Voltage-sensitive Control. New bulletin describes and illustrates maker's "Sensivolt," a static, a-c. voltage-sensitive control or circuit capable of handling large amounts of power. Includes design features and applications.—Sola Electric Co., 4633 W. 16 St., Chicago 50, Ill.
Circle 511 on inquiry card.

Noise Suppressor. New 2-page bulletin illustrates and describes maker's "Model SNS" noise suppressor for telephone circuits. Includes uses and typical installation.—Special Products Co., Silver Spring, Md.
Circle 512 on inquiry card.

Voltage Regulator. New Vol. 1 No. 3 issue of "News Currents" describes development of new "Regohm" voltage regulator with resistance of only 0.01 ohm.—Electric Regulator Corp., Ruby & Emerald St., Norwalk, Conn.
Circle 513 on inquiry card.

High-current Test Unit. New 12-page booklet illustrates importance of current-actuated protective devices (overload relays, circuit breakers) and gives instructions for testing and calibrating them with maker's high-current test unit.—Multi-Amp Corp., Harrison, N. J.
Circle 514 on inquiry card.

Meter Testing Power Supply. New 8-page illustrated Bulletin 62, gives information, specifications, operation, and installation of maker's meter testing power supply for single-phase cur-



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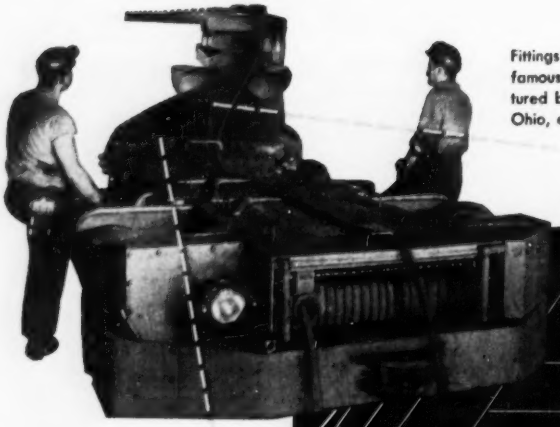

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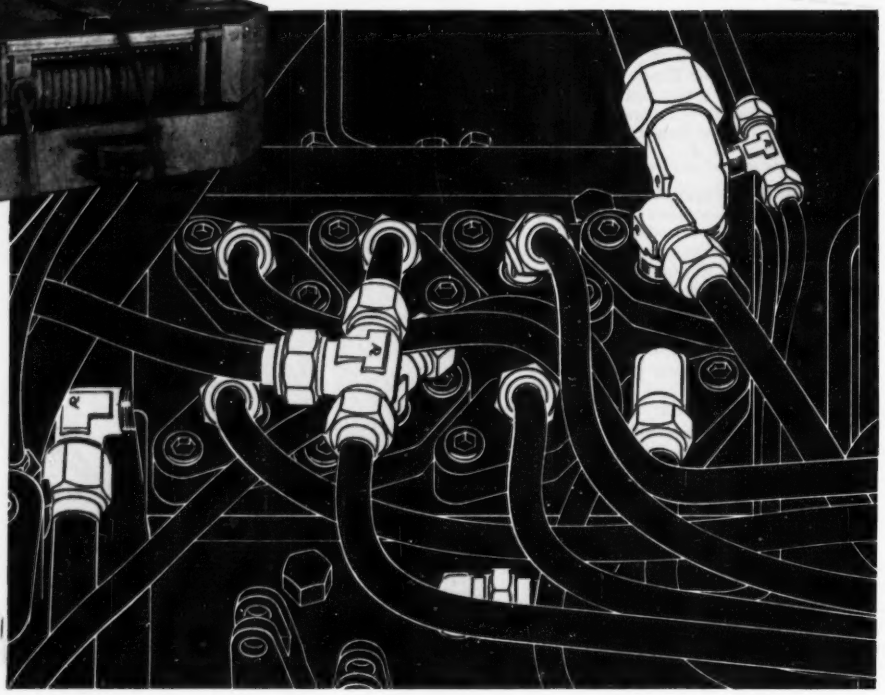

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TULSA 3, Okla.—Metal Goods Corp., 302 North Boston
CANADA—Railway & Power Engineering Corp. Ltd.
EXPORT—Mercator Corp., 438 Walnut St., Reading, Pa.

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rent, voltage, and power-factor tests.—The Eastern Specialty Co., Phila. 40, Pa.

Circle 515 on inquiry card.

OSCILLATORS

Oscillator. New 4-page bulletin describes and illustrates maker's decade-switched sweeping oscillator that covers range from 10 to 100 Mc. in 10-Mc. steps.—Decade Instrument Co., Box 153, Caldwell, N. J.

Circle 516 on inquiry card.

Audio-frequency Oscillator. New 2-page illustrated brochure presents features and specifications of maker's "Model 665" R-C-tuned AF oscillator. Also described is maker's selenium-rectifier test set.—Jackson Electrical Instrument Co., 16 S. Patterson Blvd., Dayton 2, Ohio.

Circle 517 on inquiry card.

Signal Generator. New issue of "Hewlett-Packard Journal" (Vol. 4, No. 7-8) features article on maker's signal generator for aeronautical radio and UHF television.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle 518 on inquiry card.

VALVES

Control Valves. New 44-page Catalog CV53 presents specifications, bodies, inner valves, diaphragm motors, and accessories for maker's large line of control valves—sweep flow, angle valves, Saunders bodies, high-pressure, 3-way, etc.—Kieley & Mueller, Inc., Middletown, N. Y.

Circle 519 on inquiry card.

Bellows-sealed Valves. New 2-page Specification Sheet 424 illustrates and describes maker's new "Type 27" on-off bellows-sealed fuel valve for handling volatile and toxic mediums.—Minneapolis-Honeywell Regulator Co., Sta. 64, Industrial Div., Phila. 44, Pa.

Circle 520 on inquiry card.

Butterfly Valves. New 4-page issue of "W.S. Rockwell Valve News" describes and illustrates maker's valves and production facilities.—W.S. Rockwell Co., 198 Eliot St., Fairfield, Conn.

Circle 521 on inquiry card.

Solenoid Pilot Valves. New 4-page Bulletin PB describes and illustrates maker's solenoid-operated pilot control valve for air, fluids, and gases.—Valvair Corp., 454 Morgan St., Akron 11, Ohio.

Circle 522 on inquiry card.

Cycle-controlling Valves. New 4-page Folder C describes and illustrates maker's cycle-controller valves for rubber and plastic industries.—Sinclair-Collins Valve Co., 454 Morgan Ave., Akron 11, Ohio.

Circle 523 on inquiry card.

TUBING, FITTINGS

Precision Tubing. Two new illustrated bulletins describe electrical applications of maker's small tubing in metal-shielded wires, antennas, pointers, etc.—Precision Tube Co., Inc., North Wales, Pa.

Circle 524 on inquiry card.

Flared Tube Fittings. New Catalog K-151 combines both parts specifications and technical data on maker's "Koncentrik" stainless-steel flared tube-fittings. Includes performance data and installation procedure.—The Special Screw Products Co., 5445 Dunham Road, Bedford, Ohio.

Circle 525 on inquiry card.

AIR, WATER

Pumps, Compressors. New 6-page Bulletin 546 describes and illustrates maker's 21 models of centrifugal pumps and compressors.—Pennsylvania Pump & Compressor Co., Easton, Pa.

Circle 526 on inquiry card.

Compressors. New 6-page Bulletin 600 describes and illustrates maker's "Oilfreair and Oilfregas" compressors with steel-backed carbon cylinder-liner for oil-free air.—Pennsylvania Pump & Compressor Co., Easton, Pa.

Circle 527 on inquiry card.

Air Line, Vapor Purifier. New 2-page Bulletin 200 describes and illustrates maker's line-type "Hi-ef" purifier for filtering and cleaning air and vapor lines.—V. D. Anderson Co., 1935 W. 96 St., Cleveland 2, Ohio.

Circle 528 on inquiry card.

Rotary Air Pumps. New 2-page Bulletin 125 gives design and performance data on maker's rotary oil-less air pumps that deliver oil-free air.—Gast Manufacturing Corp., Benton Harbor, Mich.

Circle 529 on inquiry card.

Demineralizer. New 2-page catalog sheet describes and illustrates maker's "M-100 Mono-Column" demineralizer.—Penfield Manufacturing Co., Inc., 19 High School Ave., Meriden, Conn.

Circle 530 on inquiry card.

TRANSISTORS, DIODES

Transistors. New 8-page illustrated Form SCD-104 presents features, operation, and characteristics of maker's four new transistors—Types 2N32, 2N33, 2N34, and 2N35.—RCA, Tube Dept., Harrison, N. J.

Circle 531 on inquiry card.

Transistors. Set of three data sheets illustrates and describes new N-P-N junction transistors "Types 2517, 2520, and 2525" made by Germanium Products Corp. and available from—Federated Semi-Conductor Co., 66 Dey St., New York 7, N. Y.

Circle 532 on inquiry card.

Transistors. Set of three 4-page illustrated data brochures present features, characteristics, and operation of maker's contact-type and P-N-P junction transistors.—Raytheon Mfg. Co., Receiving Tube Div., Newton, Mass.

Circle 533 on inquiry card.

Transistors. New 4-page mimeographed brochure presents, illustrates, and describes maker's "Types RR14, RR20, and RR21" PNP junction transistors. Includes ratings and characteristics.—Radio Receptor Co., Inc., Brooklyn, N. Y.

Circle 534 on inquiry card.

Germanium Diodes. New 4-page Bulletin GD-1 illustrates and describes maker's new line of germanium vacuum-impregnated diodes. Includes specifications, features.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

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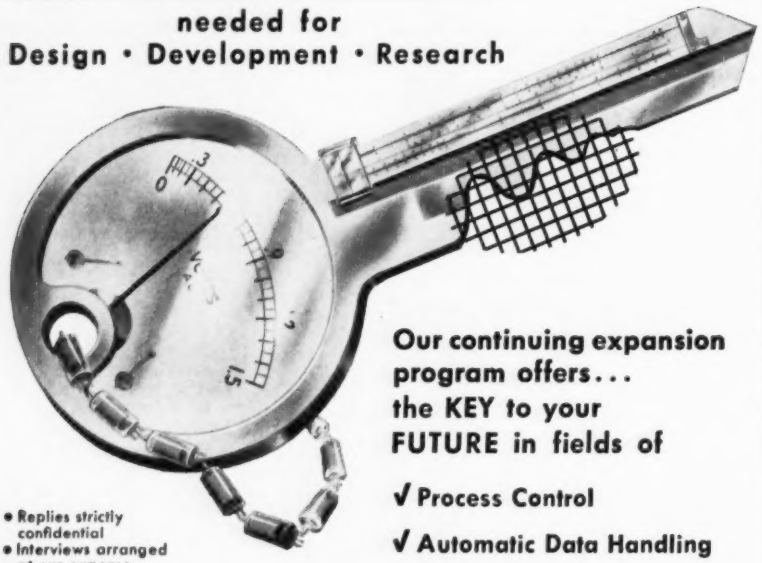

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MANUFACTURERS' NEW LITERATURE

RESISTORS, POTENTIOMETERS

Transducers, Components. New 32-page bulletin describes and illustrates maker's potentiometers, miniature PM motors, electronic transducers for temp. and press., switches, and other components for instruments and electronic equipment.—Pacific Instruments & Controls Co., 2315 Westwood Blvd., Los Angeles 64, Calif.

Circle 536 on inquiry card.

Resistors, Rheostats. New 2-page March issue of "Ohmite News" features articles on maker's rheostats meeting MIL-R-22 requirements, thin resistors, "Type AB" potentiometers, and tandem coupling kits.—Ohmite Mfg., Co., 4835 Flournoy St., Chicago 44, Ill.

Circle 537 on inquiry card.

Carbon Film Resistors. New 6-page folder gives description and specifications of maker's "Stablohm" precision microcrystalline carbon film resistors.—Chase Resistor Co., 9 River St., Morristown, N. J.

Circle 538 on inquiry card.

High-resolution Potentiometers. New 4-page bulletin describes maker's linear, ten-turn and precision potentiometers and potentiometer secondary standards.—Birklan Corp., 200 East 3rd St., Mt. Vernon, N.Y.

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Precision Potentiometers. New 2-page illustrated Bulletin 101-A presents features and specifications of maker's "Spiralpot" multi-turn potentiometer. New Bulletin 107-A presents "Universal Model 85196" precision potentiometer for computer and servo systems.—G. M. Giannini & Co., Inc., Pasadena 1, Calif.

Circle 540 on inquiry card.

Transistors. New 2-page illustrated Brochure ECG-1B presents physical and electrical specifications of maker's "Types G11 and G11A" germanium transistors.—General Electric Co., Electronics Park, Syracuse 1, N. Y.

Circle 541 on inquiry card.

Resistors. New bulletin illustrates and describes maker's new "Permohm" precision wire-wound resistors, special and MIL-R-93A types. Includes resistance ranges and types available.—Yonkers Industries, Inc., 28 School St., Yonkers, N. Y.

Circle 542 on inquiry card.

Potentiometers. New 6-page illustrated Brochure 10952 describes unitized construction of maker's line of precision potentiometers including applications, specifications and operation.—Servotrol Co., 114 W. Illinois St., Chicago 10, Ill.

Circle 543 on inquiry card.

Loading Resistor. New 2-page Bulletin SA 7004 illustrates and describes maker's "Type TT 148" loading resistor for up to 2500-hp tests. Includes characteristics, features, and construction.—Westinghouse Electric Corp., T & G Div., E. Pittsburgh, Pa.

Circle 544 on inquiry card.

Power Rheostats. New 24-page Bulletin 60a describes and illustrates maker's "Vitrohm" pressed steel rheostats, rectangular cast iron rheostats, and face plate rheostats. Includes mountings, accessories, weights, dimensions, and ordering information.—Ward Leonard Electric Co., Mount Vernon, N. Y.

Circle 545 on inquiry card.

Resistors. New 14-page brochure contains 5 bulletins illustrating and describing maker's "Nobleloy" and "Carbomite" resistors. Includes resistance values and electrical characteristics.—Continental Carbon Inc., 13900 Lorain Ave., Cleveland 11, Ohio.

Circle 546 on inquiry card.

Resistors. New 2-page Bulletin 108 describes maker's "Nobeloy" X-type precision resistors. Includes construction, features, and valves.—Continental Carbon, Inc., 13900 Lorain Ave., Cleveland 11, Ohio.

Circle 547 on inquiry card.

CAPACITORS

Capacitors. New 16-page brochure illustrates and describes maker's "West Cap" capacitors. Includes mountings, models, characteristics.—San Fernando Electric Mfg. Co., 12900 Foothill Blvd., San Fernando, Calif.

Circle 548 on inquiry card.

Suppression Capacitors. New 6-page illustrated Bulletin 651 describes maker's feed-through suppression capacitors. Includes characteristics.—Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.

Circle 549 on inquiry card.

Capacitors. New 20-page catalog covers many of maker's standard military and commercial paper-dielectric capacitors. Includes charts of insulation resistance and capacitance change vs. temperature.—National Capacitor Co., 585 Washington St., Quincy 69, Mass.

Circle 550 on inquiry card.

Capacitors. New 4-page Bulletin 5934-3-53 describes and illustrates maker's new line of subminiature metal-clad capacitors with silicone end seals and a solid dielectric for operation from minus 55 to plus 125 deg. C. Includes ratings, case sizes and typical applications.—General Electric Corp., Schenectady, N. Y.

Circle 551 on inquiry card.

Miniature Paper Capacitors. New 6-page Bulletin NB-147 illustrates and gives characteristics and types of maker's miniaturized tubular metal-cased capacitors designed to meet rigid and severe operating requirements where space limitations are an

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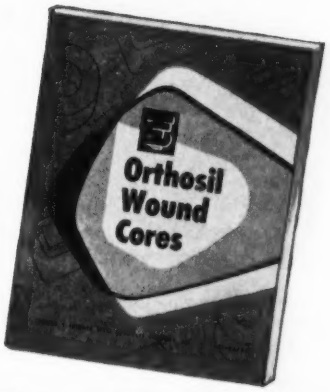

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important factor. — Cornell-Dubilier Corp., South Plainfield, N. J.
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Metallized-Paper Capacitors. New 4-page Bulletin HTMP252 announces maker's high-temperature metallized-paper miniature capacitors capable of operating at full voltage rating at 100 deg. C. Contains standard listings and specifications.—Aerovox Corp., New Bedford, Mass.
Circle 553 on inquiry card.

RELAYS, SWITCHES

Relays, Contactors, Motors. New 24-page Catalog 122 describes and illustrates maker's large line of relays, contactors, and shaded-pole motors. Relay and contactor types include power, plate, latching, impulse, miniature, sealed, etc.—Potter & Brumfield, Princeton, Ind.
Circle 554 on inquiry card.

Switches, Terminal Blocks. New 20-page Catalog 14 describes and illustrates maker's terminal blocks and switches.—Kulka Electric Mfg. Co., Inc., Mt. Vernon, N.Y.
Circle 555 on inquiry card.

Coaxial Switches. New 26-page illustrated brochure presents characteristics and features of maker's line of coaxial switches. Also described are antennas, hot-air valves, and matching networks.—Transco Products, Inc., 12210 Nebraska Ave., Los Angeles, Calif.
Circle 556 on inquiry card.

Mercury Switches. New 4-page Bulletin M-12 illustrates and describes maker's positive-contact hermetically-sealed glass-tube mercury switches. Includes special types available.—Powrex Switch Co., P.O. Box 206 B, Watertown 72, Mass.
Circle 557 on inquiry card.

Thermal Relays. New 4-page Bulletin 30 illustrates and describes maker's miniature and octal size thermal time-delay relays of hermetically sealed adjustable type. Includes cut-away views of the mechanism and metal shell, operating characteristics, and specifications.—G-V Controls Inc., 28 Hollywood Plaza, E. Orange, N. J.
Circle 558 on inquiry card.

DELAY LINES

Delay Lines. New 16-page bulletin describes, illustrates, and lists prices of maker's line of stock delay lines.—Electronics Systems Co., 578 East 161 St., New York 56, N. Y.
Circle 559 on inquiry card.

Delay Lines. New 4-page illustrated Catalog D2/53 presents features, response, applications, and specifications of maker's high-impedance delay cables with magnetic core.—Columbia Technical Corp., 5 E. 57 St., New York 22, N. Y.
Circle 560 on inquiry card.

ELECTRICAL & ELECTRONIC COMPONENTS

Subminiature Indicator Lights. New 4-page Folder L-153 illustrates and describes maker's subminiature indicator lights for plastic-plate edge lighting.—Dialight Corp., 58 Stewart Ave., Brooklyn 37, N.Y.
Circle 561 on inquiry card.

Magnetic Powders. New 8-page illustrated Catalog 354 covers technical data, photomicrographs, frequency versus Q charts, permeability rating graphs, etc., on uses and applications of annealed carbonyl iron powders, hydrogen reduced iron powders, and magnitudes.—Magnetic Powders, Inc., 1001 Fairview Ave., Johnsonburg, Pa.
Circle 562 on inquiry card.

Autotransformer. New 12-page Bulletin 424-M describes, illustrates, and gives dimensions and prices of maker's "Variac" continuously adjustable autotransformers.—General Radio Co., 275 Masachusetts Ave., Cambridge 39, Mass.
Circle 563 on inquiry card.

Autotransformers. New issue of "General Radio Experimenter" Vol. 27, No. 11, features article on "Duratrak" brush-track surface for maker's "Variac" autotransformers.—General Radio Co., Cambridge, Mass.
Circle 564 on inquiry card.

Transformers. New 28-page illustrated Catalog TR-53 presents features and specifications of more than 500 transformers, including audio, radio, industrial, miniature, toroids, pulse, etc.—Triad Transformers Corp., 4055 Redwood Ave., Venice, Calif.
Circle 565 on inquiry card.

Laminated Phenolic Nameplates. New 2-page bulletin describes maker's laminated phenolic nameplates for

product identification.—Hermes Plastics, Inc., 13-19 University Place, New York 3, N.Y.

Circle 566 on inquiry card.

Microwave Materials and Components. New 16-page bulletin describes and illustrates maker's microwave materials and components.—Henry L. Crowley & Co., Inc., 1 Central Ave., West Orange, N. J.

Circle 567 on inquiry card.

Conductive Shielding Paint. New 2-page leaflet MR11 describes maker's new electrically conductive "RS12" shielding "Micropaint" for glass TV picture tubes and other electronic shielding uses.—Micro-Circuits Co., New Buffalo, Mich.

Circle 568 on inquiry card.

Cathode-ray-tube Phosphors. New 4-page Vol. 1, No. 7 issue of "Sylvania Engineering Information Service" gives detailed information on cathode-ray-tube phosphors including color, persistence, uses, spectral curves, etc. —Sylvania Electric Products Inc., Radio Tube Div., Emporium, Pa.

Circle 569 on inquiry card.

Special Transformers. New 2-page brochure presents maker's "Zero" phase-shift computer reference-voltage transformers, pulse transformers, toroidal transformers, etc.—Transformers Inc., 532 North St., Endicott, N. Y.

Circle 570 on inquiry card.

Sealed Transformers. New 4-page brochure describes and illustrates maker's hermetically sealed transformers designed to military specifications. Includes dimension chart.—Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y.

Circle 571 on inquiry card.

Electronic Components. New 16-page issue of "This Month" presents information on distributor's line of electronic equipment. Includes aircraft type motor-generator, selenium rectifier assembly kit, Alnor pyrometers, and many components.—Herbach & Rademan Inc., 1204 Arch St., Phila. 7, Pa.

Circle 572 on inquiry card.

Glass-to-metal Seal. New 24-page Bulletin 145 is treatise on subject of glass-to-metal sealing with "Kovar" for hermetically sealing many types of electronic components. Includes techniques, phase transformation of "Kovar," dimensions, and specifications.—Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.

Circle 573 on inquiry card.

Encapsulating Material. Two new 4-page illustrated brochures present maker's "Calresin CPC" encapsulation compared for cushioning, mounting, etc. Includes properties and applications.—Calresin Corp., 333 N. Santa Anita Ave., Arcadia, Calif.

Circle 574 on inquiry card.

Electrical Embedment Resin. New 8-page illustrated brochure describes maker's "Scotchcast" resin no. 1 which is poured in liquid form around electrical components for insulation and protection.—Minnesota Mining & Manufacturing Co., St. Paul 6, Minn.

Circle 575 on inquiry card.

Slip Rings, Commutators. New 4-page illustrated brochure describes maker's precision slip-ring assemblies and commutators for electric and electronic instruments.—Electro Tec Corp., S. Hackensack, N. J.

Circle 576 on inquiry card.

Shock Mounting Systems. New 16-page Bulletin 750 illustrates development of all-metal engineered mounting systems for maximum isolation and shock protection of electronic equipment. Includes illustrations of "Met-L-Flex" unit mounts.—Robinson Aviation Inc., Teterboro, N. J.

Circle 577 on inquiry card.

Fuse Clip. New 2-page bulletin illustrates and describes maker's locking and ejector fuse clips for ferrule components. Includes dimensions.—Atlas Electronics Mfg. Co., 312 Stuart St., Boston 16, Mass.

Circle 578 on inquiry card.

Subminiature Indicator Lights. New 4-page Folder L-153 illustrates and describes subminiature indicator lights with various features.—E. Greene, Dialight Corp., 58 Stewart Ave., Brooklyn 37, N. Y.

Circle 579 on inquiry card.

Multi-contact Connectors. New 2-page Bulletin KH-1 covers maker's hermetically-sealed type KH receptacle and type RKH plug. Includes dimensions and sketches.—Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

Circle 580 on inquiry card.

Copying Machine. New 8-page illustrated Booklet A-2042 describes maker's "Model 14 Copyflex" machine for rapid reproduction of papers, charts, etc. Gives operation, uses and features. Charles Bruning Co., Inc., 125 North St., Teterboro, N. J.

Circle 581 on inquiry card.

Phonograph. New 4-page bulletin illustrates and describes maker's new phonograph development "Phono-Gard," which protects phonograph pickup head. Shows applications, operation, and models.—Grayline Engineering Co., 12233 Avenue O, Chicago 33, Ill.

Circle 582 on inquiry card.

Electric Immersion Heaters. New 4-page Bulletin 15 describes and illustrates maker's "Vitreosil" electric immersion heaters of fused silica for heating acid baths. Includes features, applications, specifications, prices, and acid containers.—The Thermal Syndicate, Ltd., 14 Bixley Heath, Lynbrook, N. Y.

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Multi-contact Connectors. New 4-page issue of "Amphenol Engineering News" Vol. 6 No. 1 illustrates and describes applications of maker's multi-contact connectors for use in various instruments. Also includes information on new brochure "OK Methods" for connector assembly.—American Phenolic Corp., 1830 S. 54 Ave., Chicago 50, Ill.

Circle **584** on inquiry card.

Directional Couplers. New issue Vol. 4 No. 5-6 of "Hewlett-Packard Journal" features article on maker's 10- and 20-db precision multihole directional couplers, and new 3-db coupler. Includes specifications.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **585** on inquiry card.

Pulse Transformer. New bulletin describes maker's "Type Pt-1 Labtrans" pulse transformer for use in the microsecond and fractional microsecond ranges. Includes specifications.—Berkshire Laboratories, Beaver Pond Road, Lincoln, Mass.

Circle **586** on inquiry card.

IF Transformers, Coils and Traps. New 8-page booklet illustrates and describes maker's printed-circuit IF transformers, coils, and traps for TV receivers with 41.25-Mc. sound IF and 45.75-Mc. picture IF. Includes dimensional outlines, response characteristics, application, and alignment.—Tube Department, Radio Corporation of America, Harrison, N. J.

Circle **587** on inquiry card.

Pilot Lights. New 16-page Form L-151 illustrates and describes maker's large line of enclosed and open pilot light assemblies, sockets, lamps, and lens holders.—The Dial Light Co. of America, 900 Broadway, New York 3, N. Y.

Circle **588** on inquiry card.

MISCELLANEOUS

Meteorological, Air-sampling Instruments. New 30-page illustrated Bulletin 41-0 presents principles and features of maker's air-sampling equipment (wet impactor, bubbler type, membrane filter, drum sampler, etc.) and meteorological instruments (wiresonde temperature bridge, wind direction recorder, etc.)—Ralph M. Parsons Co., 135 W. Dayton St., Pasadena 2, Calif.

Circle **589** on inquiry card.

Explosive-driven Chopper. New 2-page Leaflet 174-353 describes and illustrates maker's explosive-actuated destructor device for remote and rapid severance of lines, cables, etc.—Beckman & Whitley, Inc., 1096 San Carlos Ave., San Carlos, Calif.

Circle **590** on inquiry card.

Pantograph Engraver. New 12-page Catalog illustrates and describes maker's portable pantograph engraver used for 2- and 3-dimensional engraving and duplicating.—Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.

Circle **591** on inquiry card.

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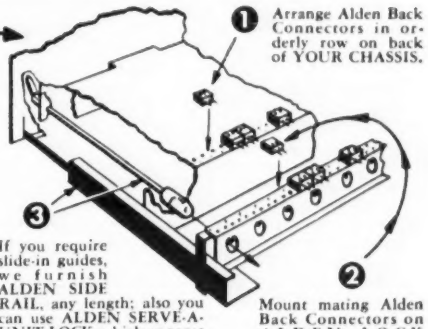
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2
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3

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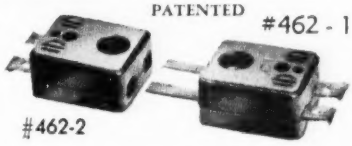
PATENTED #462 - 1



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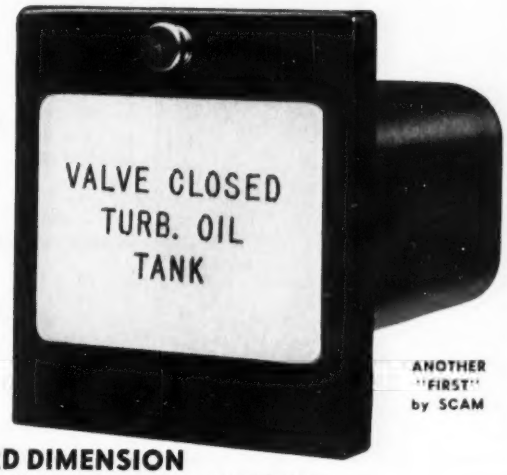

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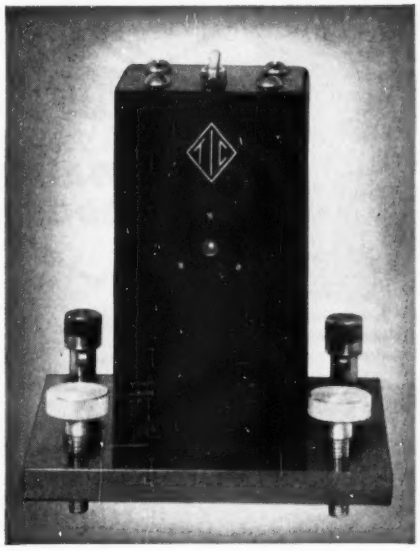

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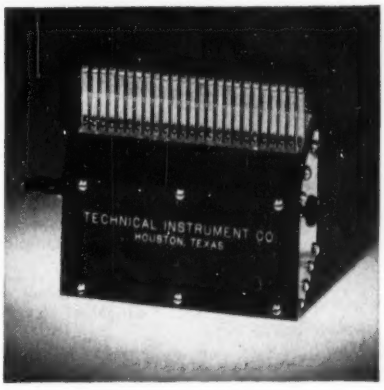

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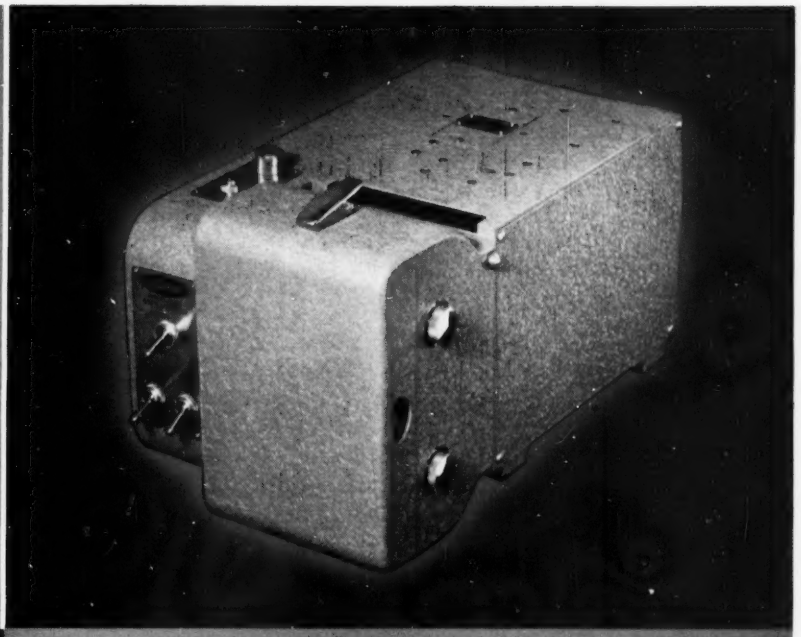

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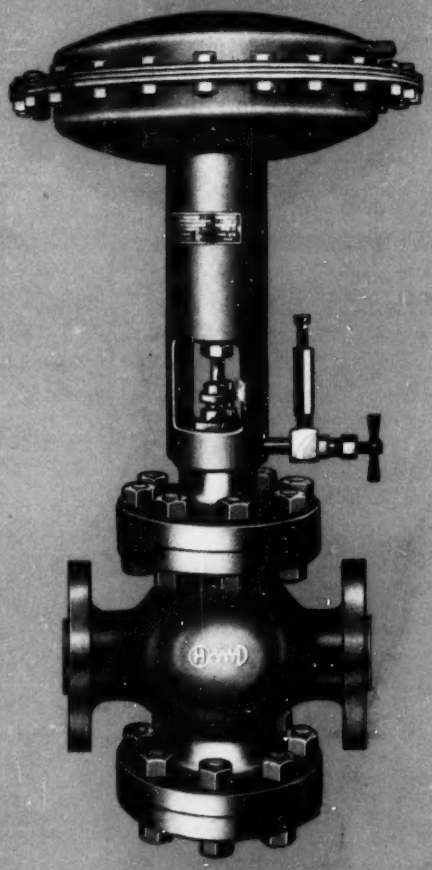

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